Nanotec®
PLUG & DRIVE

PRODUCT CATALOG

3-channel optical encoders
for BLDC and stepper motors
up to 4000 CPR, 5 V and 24 V

Linear actuators from Nema 8 to
Nema 23, up to 1000 N max. force
and 0,005 mm resolution

Compact BLDC motors,
smooth operation,
22 to 87 mm, IP65 optionally

www.nanotec.com

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The company

Nanotec Electronic is a leading manufacturer of precise, high-performance and energy-efficient drive solutions. As a family company, we think in generations and not about short-term successes. This approach is reflected in our products and in longtime customer relationships.

As a tried-and-tested partner, we support our customers as they develop optimal applications. Individualized solutions are a matter of course for us. Our claims to quality and precision at competitive prices determine our actions. Customer service is not an empty phrase at our company, it is a strategy we bring to life.

An open, creative environment, skilled and dedicated employees and a strong focus on research and development foster innovative ability and the conditions for advanced new developments.

We recognized the trend towards integrated, compact drives early on in the form of our Plug & Drive motors. Our intelligent, high-performance control systems lay the foundation for creating energy-efficient, decentralized applications. Advanced software technologies meet the need for platform independence, easier integration and quicker commissioning.

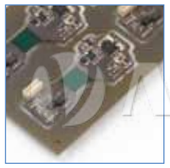
We provide a complete drive solution from a single source thanks to our modular system and a wide pallet of high-performance and high-precision stepper and BLDC motors, linear actuators and linear actuator drives in sizes starting from 10 mm.

Nanotec is an internationally active middle-sized company headquartered in Feldkirchen, Germany. We support customers worldwide via our subsidiaries in Changzhou, China and Medford, USA and more than 20 of our sales partners.

Standard and custom solutions for the optimum drive

Whether the solutions are standard or customized – you receive an optimal drive system from Nanotec for applications that demand the highest precision, reliability and functionality in the smallest spaces. When you use our motors and controllers you are building on compliance with tight production tolerances and strict quality control during every process step. Customer-specific shaft, flange and plug designs enable a quick, simple and reliable connection to the machine. Windings adjusted for the specific rotational speed optimize the working point and operating behavior.

Our control systems implement the newest technology standard. New functions such as dspDrive® are in the process of significantly improving the stepper motor's performance and resonance behavior and open up completely new implementation opportunities. The stepper motor is becoming the ideal solution for compact precision applications with high torque and low speed thanks to developments such as field-oriented torque control.



Low-cost products thanks to high-end production in China

Series production of our drives takes place at our subsidiary Nanotec ChangZhou in China and a joint venture based there. We place special value on quality assurance due to the 20 years of experience we have in motor production in Asia. We have been inspecting mechanical components using a Zeiss 3D coordinate measuring machine since 2008. At many points, we utilize self-developed automatic testing machines for the final inspection, such as for testing counter EMF or the axial play of motors. Stable process and a high degree of in-house production depth are the results of high-quality machinery and thorough employee training.

Quality & environment

The highest quality is a benchmark and a commitment for us. Certification by TÜV Management Service in accordance with the newest ISO 9001:2008 standard used as the basis for all of our production and operations does not just set benchmarks. It is also used as an incentive to evaluate and improve our internal and external processes. All of our employees around the globe adopt a high degree of quality consciousness that each individual takes to with great commitment.

Nature, society, business and each individual company are part of a global, ecological system whose balance and diversity are critical for the continued existence of all life. As a globally active commercial enterprise, we are addressing our particular responsibility for preserving natural conditions. Careful handling of resources, avoiding waste, emissions and scrap, using renewable energy and increasing energy efficiency for our drive solutions are an indispensable part of our business objectives and our overall entrepreneurial responsibility with respect to the definition of corporate social responsibility (CSR) from the European Commission.

Worldwide sales network

Nanotec products are available both directly from us and via a worldwide network of sales partners.
A current list of our sales partners can be found at http://en.nanotec.com/nanotec_kontakt.html

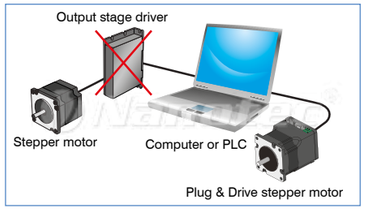
Our complete range of products can be found on the Internet at: www.nanotec.com

Our complete range of products can be found online, and a selection of these products is provided here.

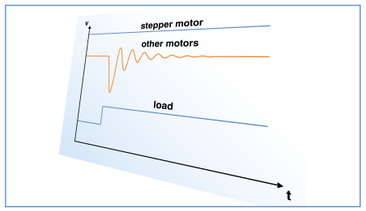
- Order quantities up to 25 units can be ordered directly via our website
- Technical drawings are available directly on the product page as PDF, DWG, DXF or 3D – with no registration or long, drawn-out searches
- Torque characteristics of all motors at different operating voltages and controls
- Selection aid: You can quickly find a suitable motor using our stepper motor assistant
- Product configurator: Suitable control systems and potential options like rotary encoders, gearing, safety brakes, etc. are shown directly.
  You do not have to go through an inconvenient search to find out which products work together

Application benefits

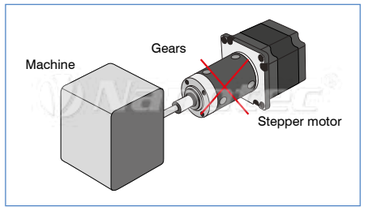
Stepper motors are digitally controlled and regulated drives that have achieved the highest level of acceptance and prevalence since the technology transition (from analog to digital technology and current software solutions) due to favorable prices with maximum service life and little control required.



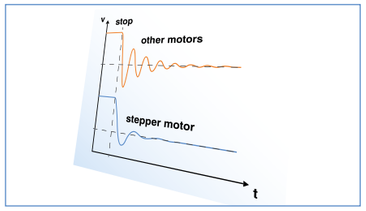
a) PC+PLC-capable (directly controllable via PC, PLC and microprocessor)
Plug & Drive motors have the highest productivity increase due to the use of computers even at the lowest, decentralized machine level. Nanotec was the first provider in the world that met the demand for a compact, efficient and economical drive system with an industrial-grade Plug & Drive motor.
Not only were development, wiring and installation effort for a complete drive unit drastically reduced and the EMC compatibility and machine availability increased, but commissioning and servicing were simplified enormously. New and close partnerships to the benefit of better and lower-priced end products are growing constantly along with the on going continued development of options for customer-specific requirements.



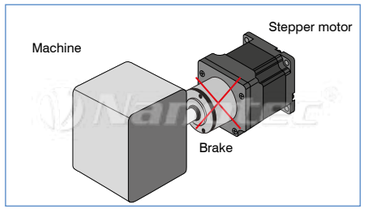
b) Turning speed stability
"No drop in speed when load changes" - the stepper motor meets this requirement like no other motor, without additional effort. Precisely when using controls for precise speed, synchronization or ratios (such as for precise metering pumps), the stepper motor can achieve higher or finer resolutions thanks to digital processing. The improved control, process and surface quality is not just a theoretical advantage in this context.



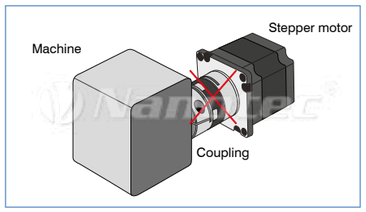
c) Direct drive
Stepper motors have the highest torque in the low speed range and still enable acceptable concentricity properties up to approximately 2 rpm using Nanotec micro stepper drivers. Other motors often require gears for this in order to meet the required speed and force requirements. Direct drives reduce system costs while increasing operating safety and service life. Gears are certainly indispensable for adjusting performance and power if the space requirement is reduced or when external inertia torque is high.



d) Positioning accuracy
As a result of the small step angle, stepper motors also have, in addition to the lowest over run, the smallest transient response. Even without external path or angle sensors, stepper motors fulfill outstanding speed and positioning tasks. The precision or resolution can even be increased further without additional effort using Nanotec motor controllers thanks to micro step switching. All Nanotec stepper motors are also available with affordable encoders for detecting blockages and closed loop applications.



e) High stiffness without brake
Stepper motors have the highest holding torque when idle and thus offer a high degree of system rigidity. An external brake can be omitted thanks to this ability, unless a safety brake is necessary for the Z-axis.



f) Avoiding damage to machines and injuries
The occasionally mentioned disadvantage of "falling out of step" during a motor blockage is even an advantage in some cases in relation to constantly increasing safety requirements. Slip and overload couplings are not normally required in statutory safety requirements in conjunction with stepper motors.

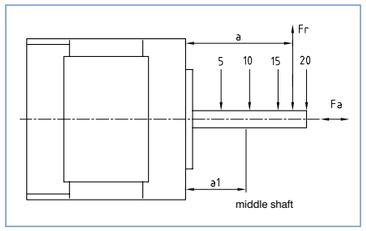
Reliability

All Nanotec motors are brushless, have high-quality ball bearings in the front and rear bearing shells and reach a life expectancy of more than 20,000 operating hours under the specified operating conditions. The information on the service life is based on the findings of renowned ball bearing manufacturers and our own tests. The calculated L10h values are only theoretical values at optimal operating conditions; they do not provide a claim guarantee.

a) Max. admissible axial and radial forces (Fa and Fr)

Forces in N	Radial forces (Fr)				Axial forces (Fa)
Distance a (in mm)	**5**	**10**	**15**	**20**	
ST20 Shafts Ø 4.00 mm	30	18	14	8	4
ST28; ST41; ST42 Shafts Ø 5.00 mm	58	36	26	20	7
ST57; DB57 Shafts Ø 6.35 mm	130	90	70	52	10
ST57; ST59; ST60 Shafts Ø 8.00 mm	163	112	85	63	14
ST89; DB87 Shafts Ø 14.0 mm	535	355	265	200	65; 60
ST110 Shafts Ø 19.05 mm	640	425	320	240	80

Type	Fr (distance a1) (in mm)	Fa (in N)
SP06-SP08	1.0	0.5
SP10-SP20	2.0	1.0
SP25-SP35	3.0	1.5
SP42-SP55	5.0	2.0



b) Reduction of the average expected service life

Negative influences on the average expected service life L10 specified by Nanotec are:

- Intermittent load
- Excessive radial and axial loads
- Vibration and oscillation, very high cyclical acceleration
- Inaccurate angular and centering alignment
- Ambient conditions such as dust, humidity, corrosive gases, etc.
- At an increased operating temperature (over approx. +70 °C, the service lifetime is cut in half per ~+15 °C due to the shortened lubrication periods)

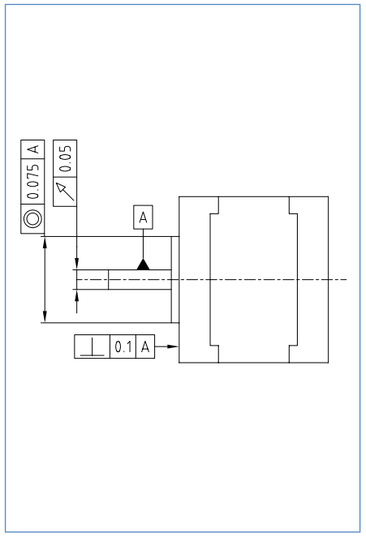
Adapted greases and lubricant fillings could be necessary in the event of a very high number of oscillating movements within a 360° angle. Customer-specific motors with ball bearings of this type are available on request.

c) Machining of the motor shaft!

In the event of excessively high radial forces or external shocks, the inner shaft is bent and the rotor can touch the stator. This can result in damage to the rotor or stator causing microparticles to accumulate in the air gap and cause noises and blockages.
Also, in the **mechanical finishing of the motor shafts,** in addition to the maximum deflection, attention must be paid especially to the **necessary sealing,** so that no microparticles can get into the engine compartment through the force ball bearings despite the strong magnetic attraction of the rotor.

Common specifications of the ST... types and DB motors

	Motor size	20 (28)	41 (42)	59 (57.60)	89	110
Concentricity:	↗	0.05 mm	0.05 mm	0.05 mm	0.05 mm	0.05 mm
Parallelism:	⊥	0.1 mm	0.1 mm	0.1 mm	0.075 mm	0.76 mm
Concentricity:	◎	0.075 mm	0.075 mm	0.08 mm	0.075 mm	0.076 mm



Shaft radial clearance:	0.025 mm maximum (at 5 N radial load)
Shaft axial clearance:	0.075 mm maximum (at 10 N axial load)
Step angle precision: (SH,ST)	at full step ± 5% non cumulative (no load)
Insulating resistance:	100 MOhm at normal operating temp. and humidity measured between the winding and motor housing
Dielectric strength:	0.5 kV at 50 Hz for at least 1 minute
Insulation class:	Class B (130°C)
Temperature increase:	80°C or less detected using the measurement of the resistance change after the nominal voltage was applied to the blocked stepper motor
Operating temperature range:	-10°C to +50°C
Storage temperature:	-20°C to +70°C
Humidity (working range):	20% to 90% non-condensing (free of corrosion)
Humidity (storage range):	8% to 95% non-condensing (free of corrosion)

You can find detailed information in the data sheets.

Construction, protection classes and safety considerations

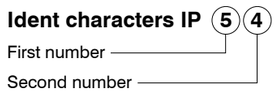
a) General construction

Almost all stepper motors are manufactured according to ISO 9001 and meet the safety requirements contained in applicable standards and regulations when used properly. The motors are a closed design (protection class IP 20) with an opening provided with a small sleeve for connection lines. The end shields are made of cast aluminum and are carefully connected using a centering ring and stator rings. Ball bearings lubricated to last the service life were sought and tested for processing and smooth running. The stator plates are connected between the cast rings at every corner using rivets or screws.

b) Protection classes (acc. to DIN EN 60529: 2000 - 09)

Nanotec also offers stepper motors suitable for tough environmental conditions.

Protection classes



First number	Protection against contact and foreign bodies
0	No protection
1	Protection against large foreign bodies (greater than 50 mm Ø)
2	Protection against medium-size foreign bodies (greater than 12.5 mm Ø)
3	Protection against small foreign bodies (greater than 2.5 mm Ø)
4	Protection against granular foreign bodies (greater than 1 mm Ø)
5	Protection against heavy dust deposits
6	Protection against penetration of dust

Second number	Protection against water
0	No protection
1	Protection against vertically dripping water
2	Protection against dripping water falling at an angle (up to 15° C to the ↑)
3	Protection against spray water (up to 60°C to the vertical ↑)
4	Protection against spray water (from all directions)
5	Protection against hose water (12 l/min; min 0.3 bar)
6	Protection against powerful hose water (100 l/min; p~1 bar)
7	Protection against sporadic immersion
8	Protection against submersion

c) Safety instructions

The use of electromotors and the use of any concentrated energy is linked with potential hazards. Using appropriate constructive design, correct selection, proper installation and thoughtful use, the degree of danger can be reduced significantly. In regard to the load and environmental conditions, the user has to pay attention to correct installation and use of the devices. Therefore, it is of the utmost importance that the end user take all electrical, thermal and mechanical safety regulations into account.

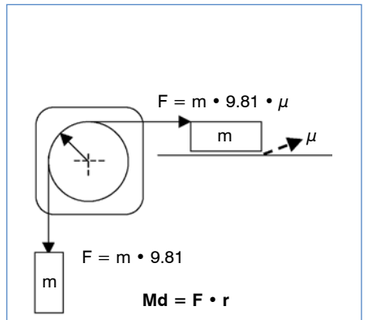
Performance calculation and appropriate motor selection

The necessary power capacity and size of the motor depends primarily on the external mass movements and their frictional conditions.

1) Friction force or moment of friction

a) Linear: $F = m \cdot g \cdot \mu$
The **friction F** (N) is determined primarily by the mass = **m** (weight kg) and the friction coefficient = $\boldsymbol{\mu}$.

b) Rotation: $Md = F \cdot r$
The **torque Md** (Ncm) is determined by the **friction F** (N) and the **lever arm r** (cm) (depending on the point of contact and distance to the force action line).

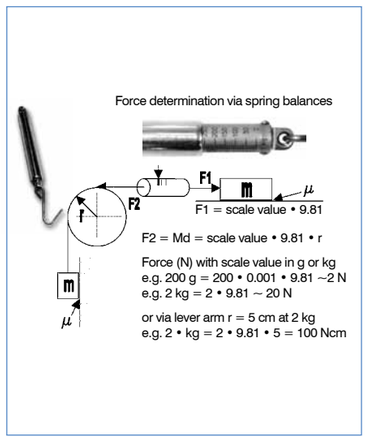


2) Acceleration torque

Due to the law of inertia, the force or torque is greater the faster the mass is accelerated:

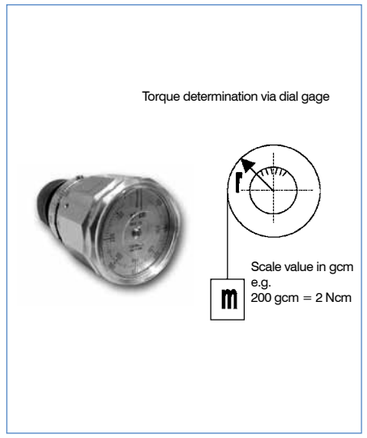
a) Linear: $F = m \cdot a$
$(a = v_e - v_a/t)$
v_e = end speed, v_a = starting speed

b) Rotation: $Md = J \cdot a$
(J= pol. inertia torque, e.g. full cyl. $0.5 \cdot m \cdot r^2$)
$(a = n_e - n_a/t)$
n_e = end speed, n_a = starting speed



3) Power rating

$P_2 = Md \cdot 6.28 \cdot f / z$ (Md = torque from the motor curve, f = step frequency in Hz, z = steps/rotation)



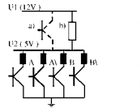
4) Simple torque determination

Apart from the mathematical determination, the determination of force and torque by means of spring balance and torque gage is especially advantageous because it takes into account the difficult-to-determine friction factor.

Controllers and switching features

Almost all stepper motors can be provided with 4, 6 or 8 connection lines/leads, where 4 leads are suited solely for bipolar operation, 6 leads are for unipolar and somewhat limited bipolar operation and 8 are suitable for unipolar and bipolar operation. Unipolar operation is extremely simple with just 4 switches but, with approximately 30% higher torque, is still rarely used today due to the highly integrated availability of constant current bipolar driver ICs. Even constant voltage operation is scarcely represented on the market due to the high power loss.

Unipolar connection



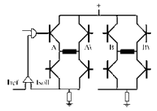
e.g. Constant voltage operation

a) Bilevel

b) Series resistor

Unipolar switching sequences					
Mode		winding			
1/1	1/2	A	A\	B	B\
1	1	+	0	0	+
	2	+	0	0	0
2	3	+	0	+	0
	4	0	0	+	0
3	5	0	+	+	0
	6	0	+	0	0
4	7	0	+	0	+
	8	0	0	0	+
1	1	+	0	0	+

Bipolar switching sequences



e.g. constant current operation

Unipolar switching sequences			
Mode		winding	
1/1	1/2	A	B
1	1	+	+
	2	+	0
2	3	+	-
	4	0	-
3	5	-	-
	6	-	0
4	7	-	+
	8	0	+
1	1	+	+

Stepper motor animation

Stepper motor animation at www.nanotec.com

Connection arrangement of stepper motors
Stepper motors offered by Nanotec can be operated using various circuit types that each lend the motor different characteristics. The 4-lead design is already connected internally; there is only one connection option. Motors with 6 leads can be operated with one winding half or in series, those with 8 wires can be operated in all of the listed circuit types. Only bipolar activation, which is used almost exclusively today, is taken into consideration here.

1. One winding half: Only half of the motor's windings are used in this case. Therefore, the holding torque to be achieved is also less than in other circuits. This circuit only provides benefits at a high speed range for 6-lead motors, which can be seen specifically in the respective motor characteristic curves.

2. Parallel: The highest motor output is achieved in this circuit. Due to the low inductance, the motor continues to keep the torque constant even at high speeds, however, a high phase current is also required.

3. Series: This circuit is well-suited for the low speed range where high torque is achieved with low current. Due to the high inductance, the torque quickly drops off at high speeds, however.

The values specified in the data sheet always refer to one winding half. The rule for converting to series or parallel circuits for individual parameters is shown in the following table. This function can also be carried out online on the overview page for the individual stepper motor series (under the Activation type).

Value	1 winding half as in datasheet	Series	Parallel
Resistance	R	2 * R	R/2
Inductance	L	4 * L	L
Phase current	I	I/√2	I * √2
Holding torque	M	M * √2	M * √2

The holding torque is achieved at the respective nominal current. If the current deviates, then the value can be calculated accordingly from the proportionality between phase current and holding torque. Thus, half the current results in half of the holding torque (for the same circuit).

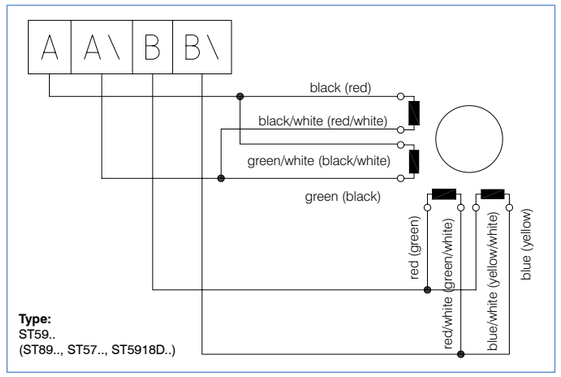
! Caution: This context only applies to holding torque and to the low speed range (where torque does not yet drop off), but not for the entire motor curve. At high speeds, the configured current can no longer achieve its maximum value since the switching processes at the winding are then too fast. This (real) current reduction leads to a decrease in the motor curve as speed increases.

It is also possible to operate the motor briefly with higher current. In that case, however, care must be taken not to exceed a housing temperature of 80°. Saturation occurs at 1.5-2 times the value of the nominal voltage in the process depending on the motor, after which the moment no longer increases.

Motor connection: Nanotec stepper motors

8 leads - parallel for high frequency > 1 kHz

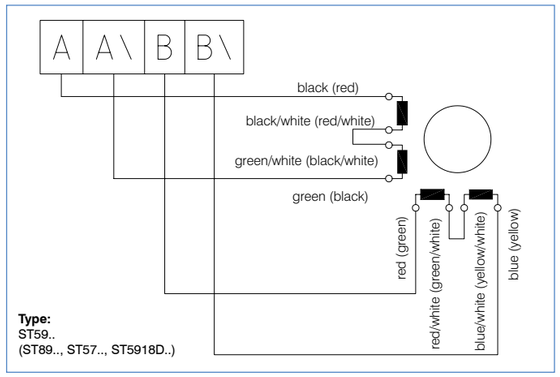
Current per winding x 1.4 = current per phase
E.g.: Current / winding 1A = **1.4 A** / **phase**



Type:
ST59..
(ST89.., ST57.., ST5918D..)

8 leads - series for low frequency < 1 kHz

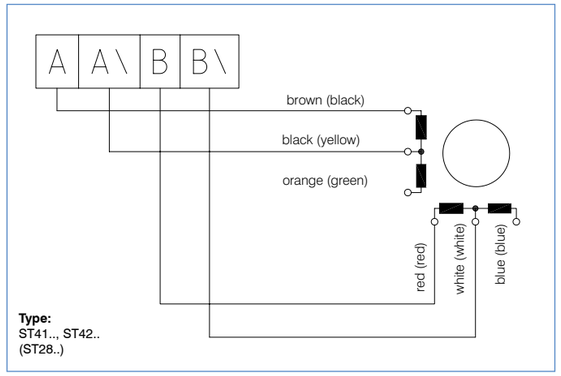
Current per winding x 0.7 = current per phase
E.g.: Current / winding 1A = **0.7 A** / **phase**



Type:
ST59..
(ST89.., ST57.., ST5918D..)

6 leads - 1 winding halves for high frequency >1 kHz

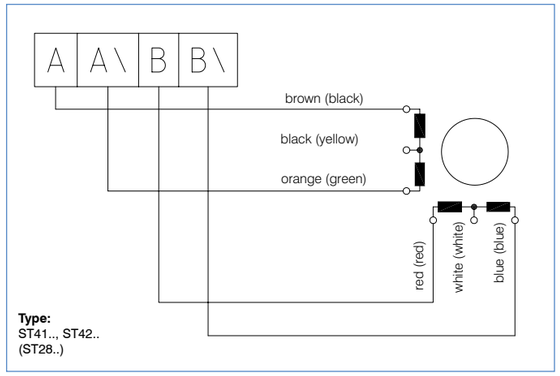
Current per winding = current per phase
E.g.: Current / winding 1 A = **1 A** / **phase**



Type:
ST41.., ST42..
(ST28..)

6 leads - serial for lower frequency < 1 kHz

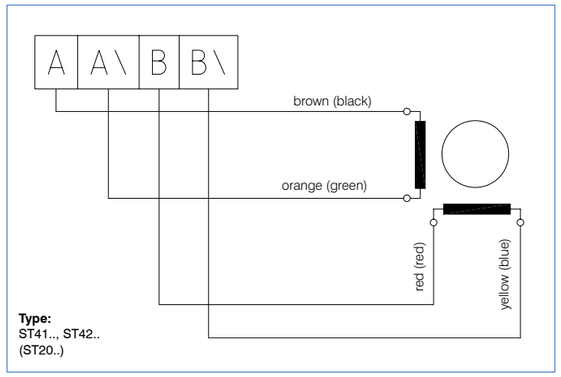
Current per winding x 0.7 = current per phase
E.g.: Current / winding 1 A = **0.7 A** / **phase**



Type:
ST41.., ST42..
(ST28..)

4 leads

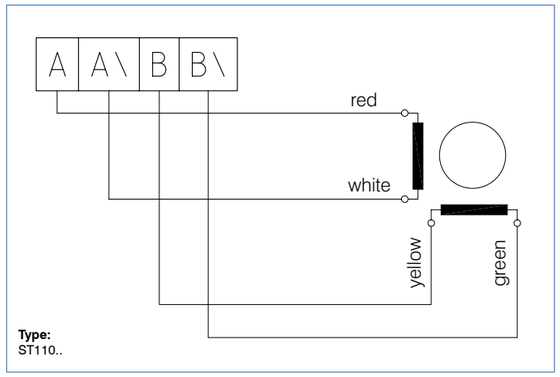
Current per winding = current per phase
E.g.: Current / winding 1 A = **1 A** / **phase**



Type:
ST41.., ST42..
(ST20..)

4 leads

Current per winding = current per phase
E.g.: Current / winding 1 A = **1 A** / **phase**



Type:
ST110..

Notes

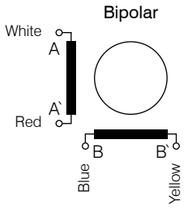
2-phase stepper motors

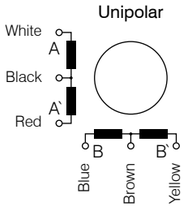
Permanent magnet stepper motors, 7.5°-18°, types SP0618 - SP5575

Option

Gear Controller

Pin configuration





- with molded-on plug
- with high-quality plain bearings on both sides

Due to the simple construction, SP permanent magnet motors are suited for inexpensive device applications where large step angles are sufficient.
The SPG variants have an integrated gearing with a gear reduction of 50 or 102.

Order identifier

SP(G) 3575 S 0506 -(A)

A = one shaft end

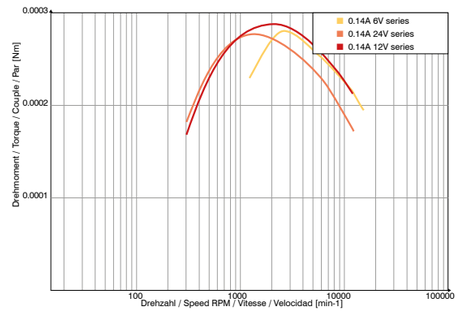
Available versions (other version of winding, shaft and flange on request)

Type	Step Resolution °	Current per winding A/winding	Voltage per winding V/winding	Holding torque N cm	Resistance per winding Ohm/winding	Inductance per winding mH/winding	Rotor inertia torque g cm²	Weight kg	Dia meter (mm)
SP0618M0204	18°	0.250	3.0	0.045	12.0	10.00	0.002	0.002	6
SP0818M0204	18°	0.238	5.0	0.059	21.0	1.37	0.002	0.003	8
SP1018M0204	18°	0.220	3.3	0.160	15.0	3.00	0.010	0.004	10
SP1518M0104	18°	0.065	12.0	0.320	190.0	37.00	1.000	0.012	15
SP1518M0204	18°	0.24	12.0	0.350	50.0	9.00	1.000	0.012	15
SPG1518M0504-50	0.36°	0.50	5.0	13.500	10.0	2.30	1.000	0.012	15
SPG1518M0504-102	0.176°	0.50	5.0	20.000	10.0	2.30	1.000	0.012	15
SP2018M0506	18°	0.500	5.0	0.500	10.0	1.85	1.000	0.026	20
SP2515M0406	15°	0.430	5.0	1.000	11.5	2.30	1.000	0.036	25
SP2575M0206	7.5°	0.240	12.0	1.600	50.0	12.00	1.000	0.036	25
SP2575M0506	7.5°	0.500	5.0	1.400	10.0	2.00	1.000	0.036	25
SP2575M0704	7.5°	0.760	3.8	1.000	5.0	3.00	1.000	0.036	25
SP3575S0506	7.5°	0.500	5.0	4.000	10.0	3.80	5.000	0.090	35
SP3575M0906	7.5°	0.860	5.0	5.500	5.8	6.50	7.500	0.090	35
SP4275S0606	7.5°	0.590	5.0	5.000	8.6	4.50	9.600	0.110	42
SP4275M0806	7.5°	0.810	5.0	6.000	6.2	5.50	9.600	0.130	42
SP5575M0106	7.5°	0.120	12.0	15.000	100.0	107.00	12.500	0.270	57
SP5575M0604	7.5°	0.625	5.6	12.000	9.0	19.50	12.500	0.270	57

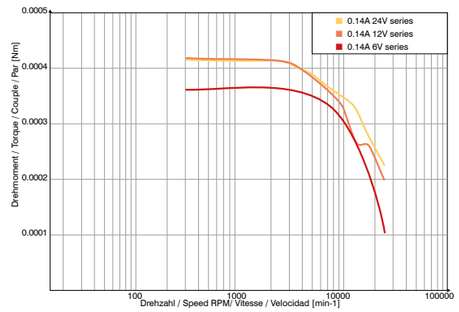
All data refer to 1 half of the winding or unipolar!

Speed/torque curves

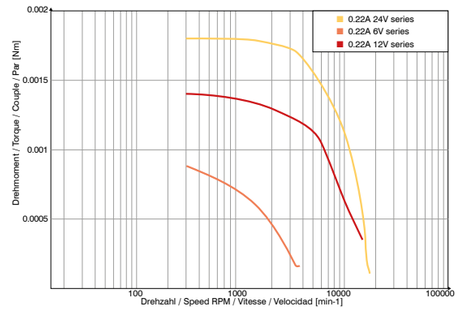
SP0618M0204



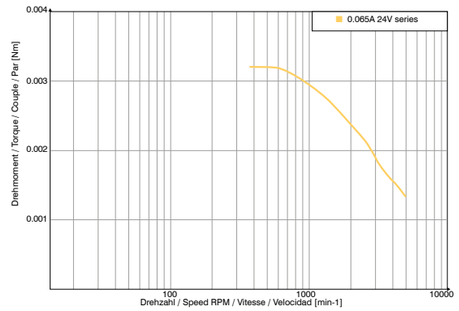
SP0818M0204



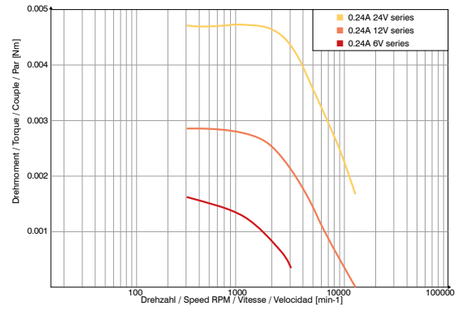
SP1018M0204



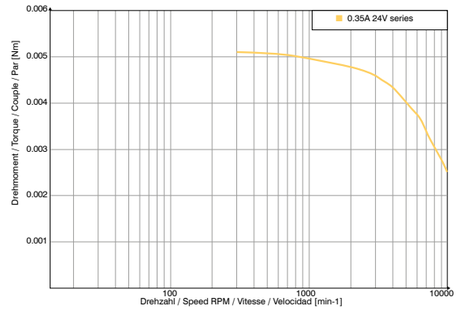
SP1518M0104



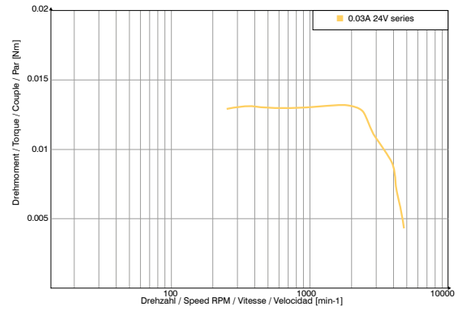
SP1518M0204



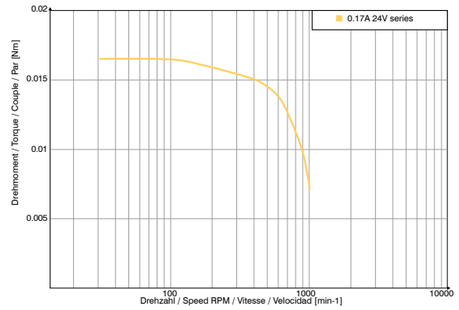
SP2018M0506



SP2515M0406

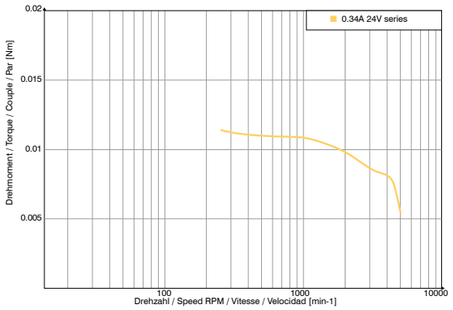


SP2575M0206

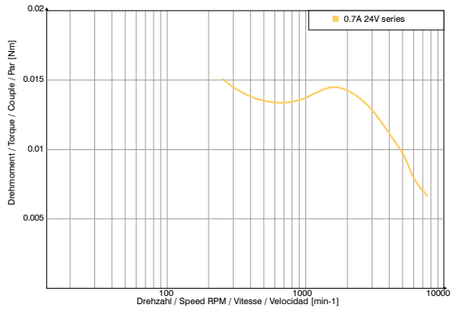


Speed/torque curves

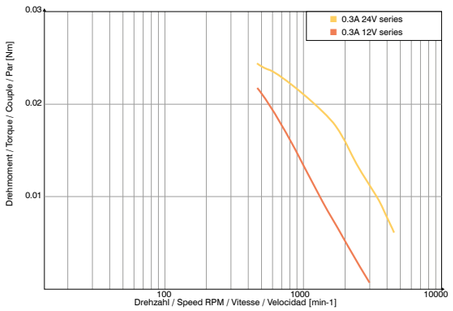
SP2575M0506



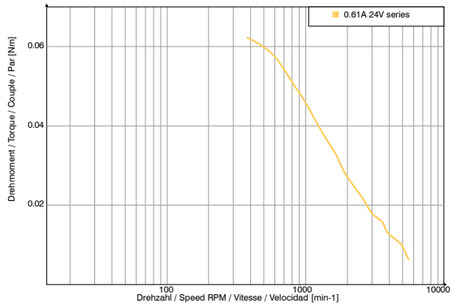
SP2575M0704



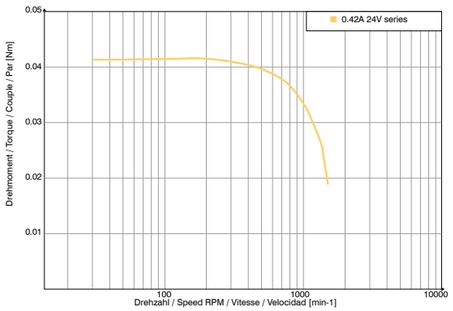
SP3575S0506



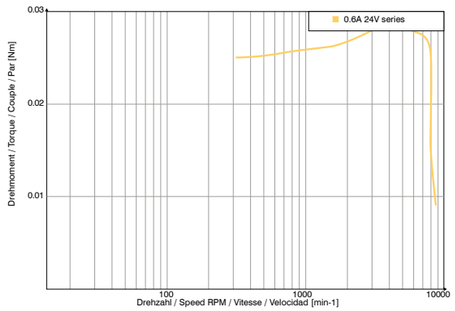
SP3575M0906



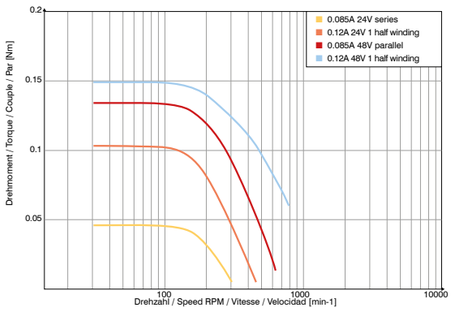
SP4275S0606



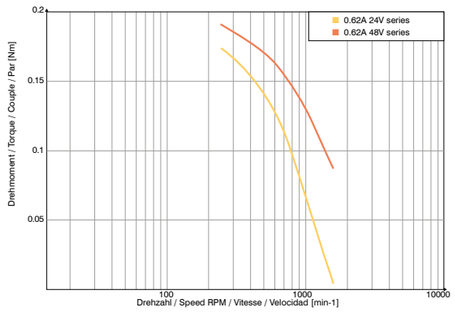
SP4275M0806



SP5575M0106

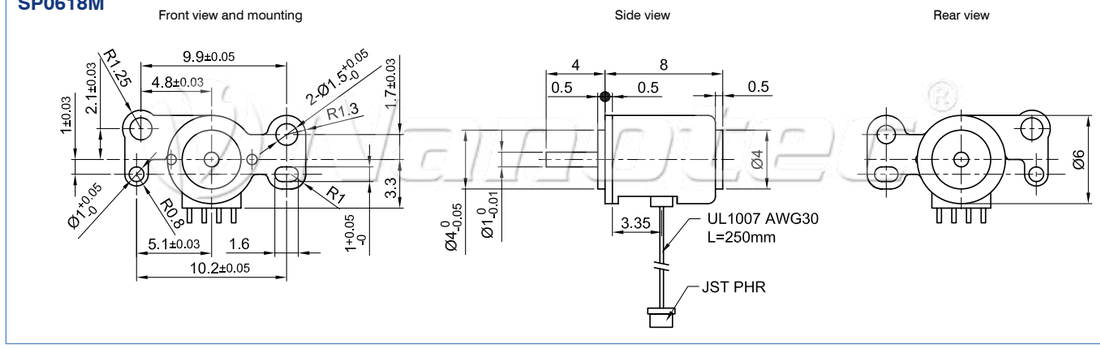


SP5575M0604

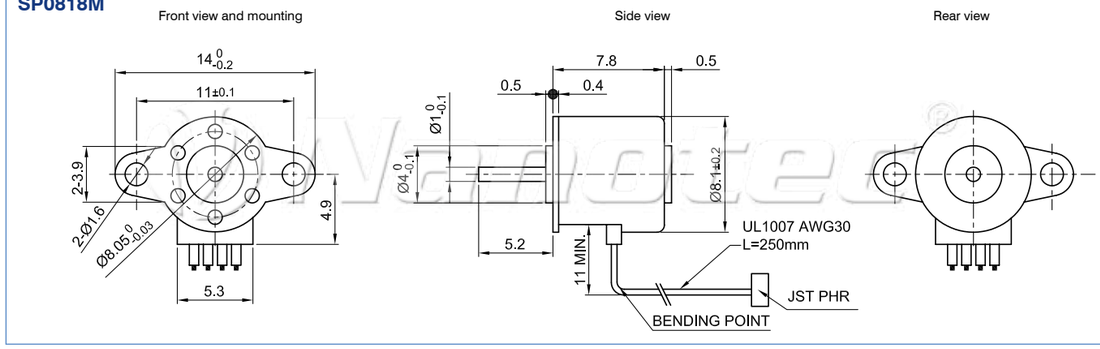


Permanent magnet stepper motors, 7.5°-18°, types SP0618 - SP5575

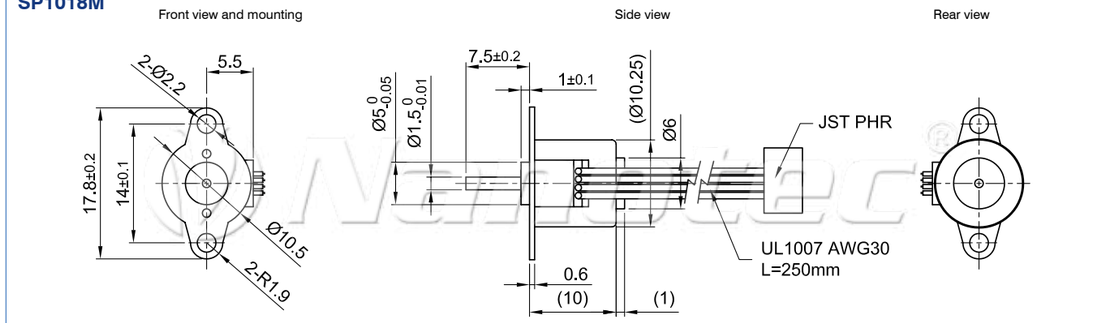
SP0618M



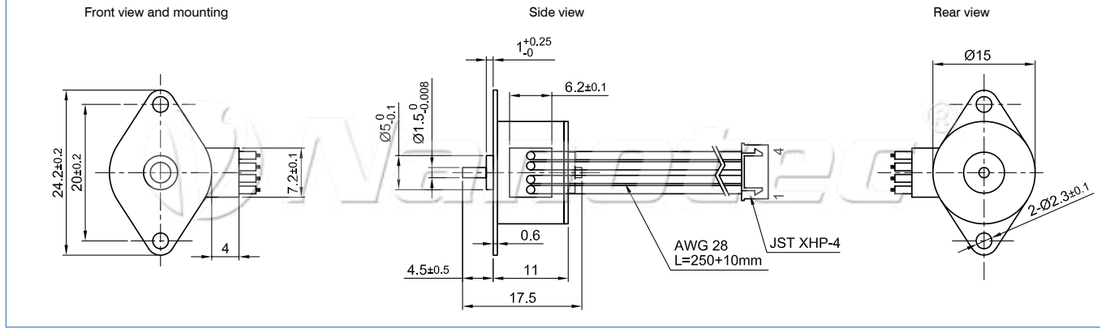
SP0818M



SP1018M

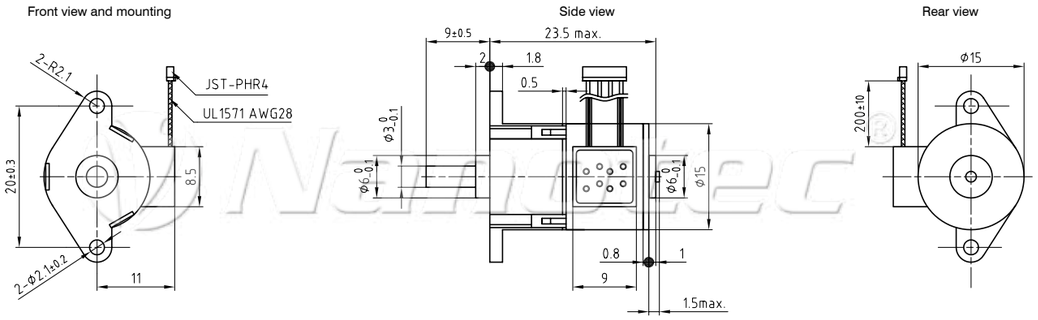


SP1518M

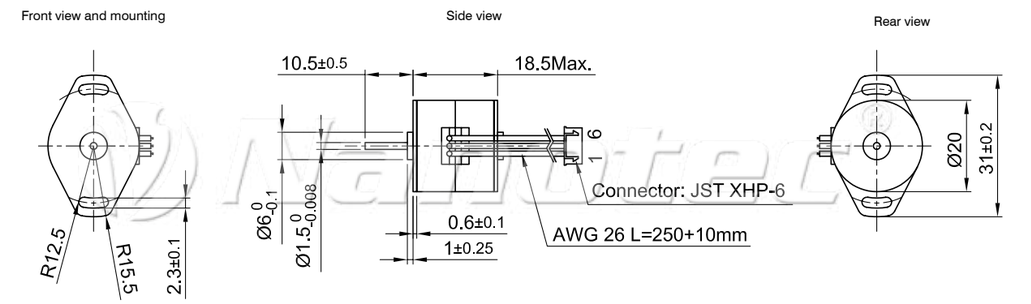


Permanent magnet stepper motors, 7.5°-18°, types SP0618 - SP5575

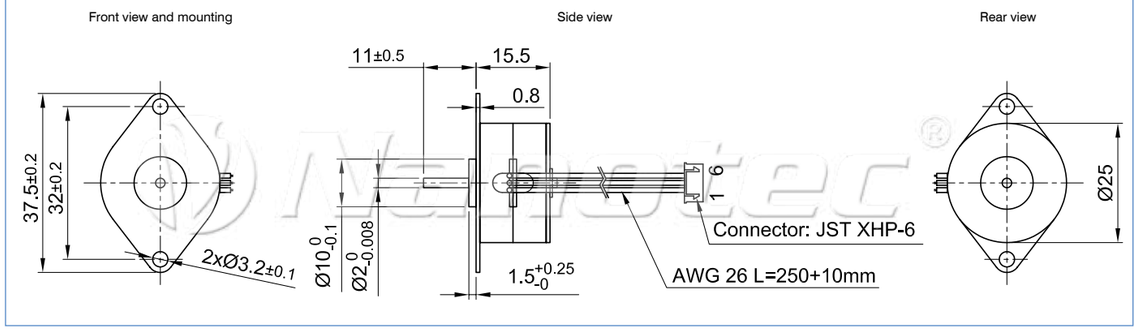
SPG1518M



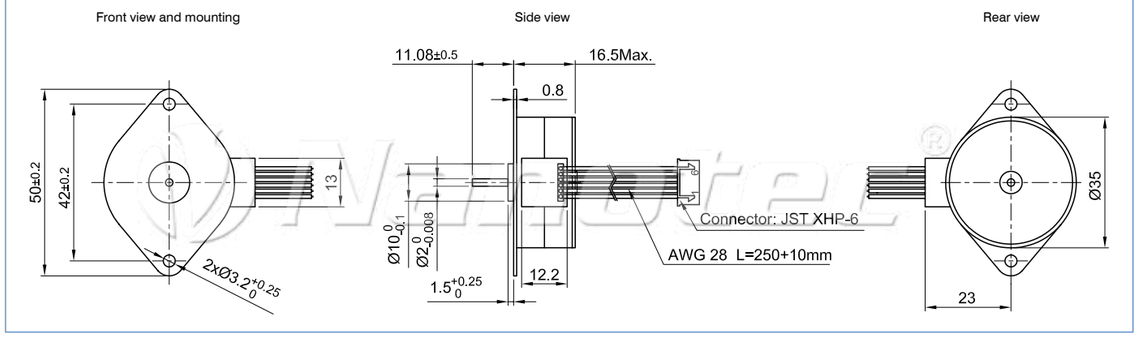
SP2018M



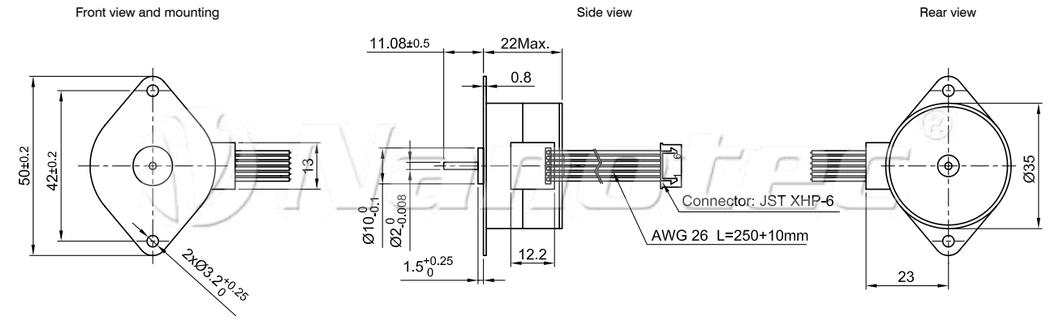
SP2515M



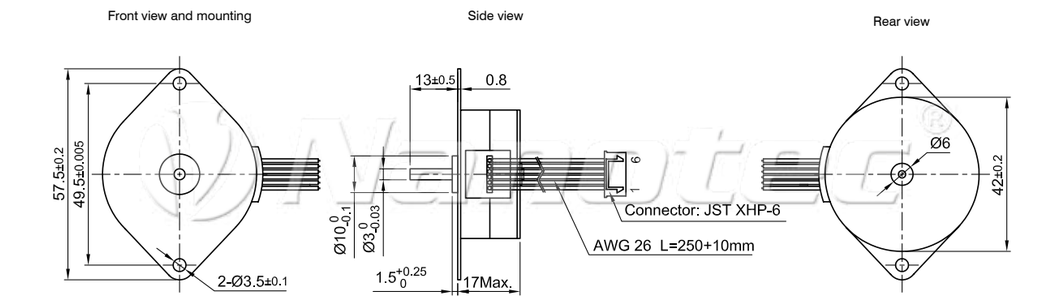
SP3575S



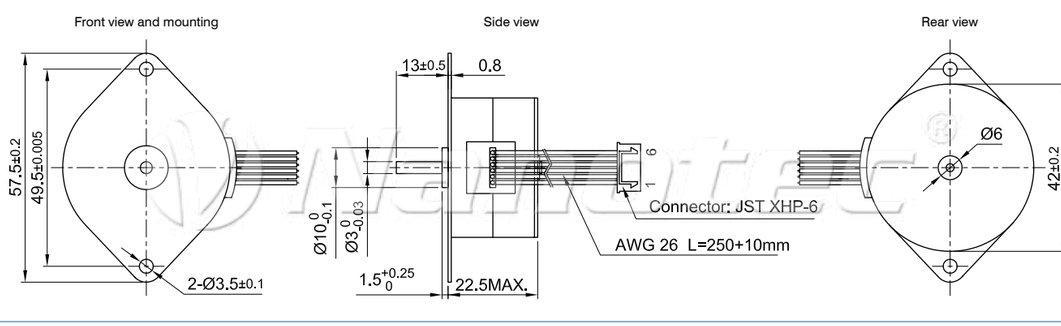
SP3575M



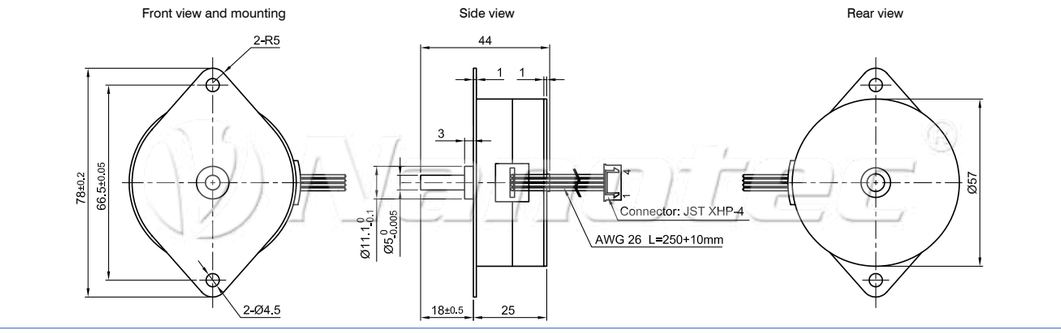
SP4275S



SP4275M



SP5575M

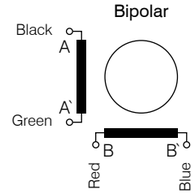


Type ST2018 - sizes S, M, L - 1.8°

Option

Gear Controller Encoder

Pin configuration

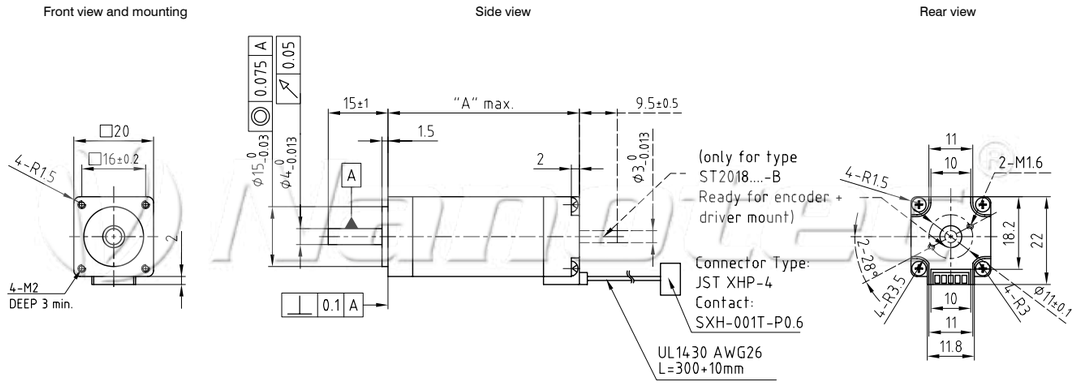


Order identifier

ST 2018 S 0604 -A

A = one shaft end
B = two shaft ends for encoder

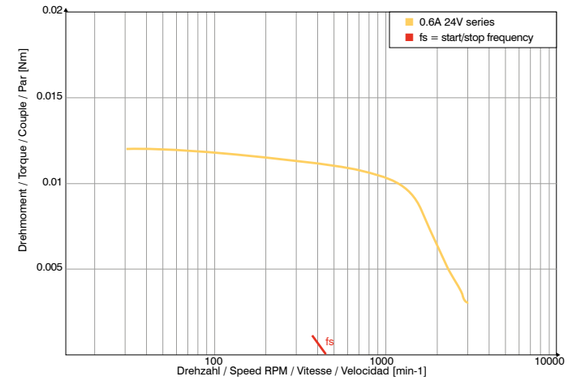
Outline drawing (in mm)



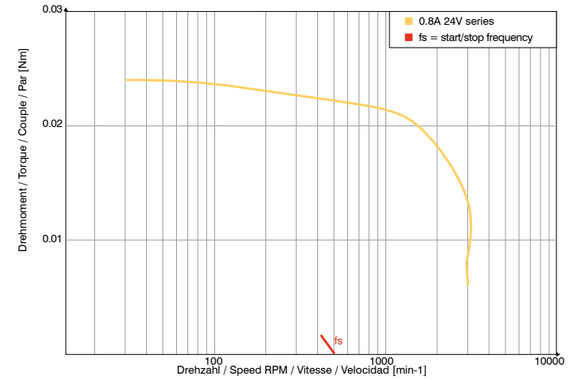
Available versions (others on request)							
Type	**Current per winding** A/winding	**Holding torque** Ncm	**Resistance per winding** Ohm/winding	**Inductance per winding** mH/winding	**Rotor inertia torque** g cm²	**Weight** kg	**Length "A"** mm
ST2018S0604	0.60	1.80	6.5	1.70	2.0	0.06	33
ST2018M0804	0.80	3.00	5.4	1.50	2.0	0.08	42
ST2018L0804	0.80	3.60	6.0	2.20	2.3	0.09	48

Speed/torque curves

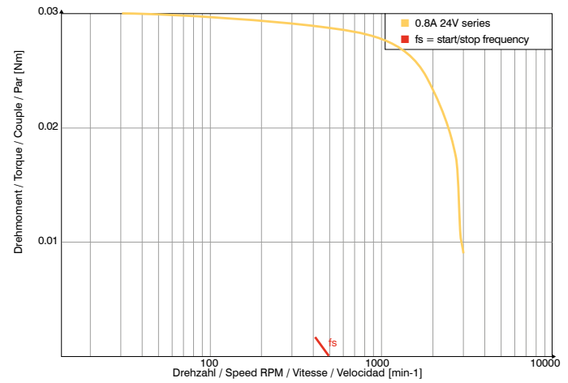
ST2018S0604



ST2018M0804



ST2018L0804

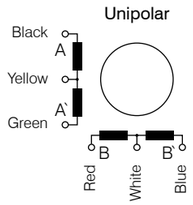


Type ST2818 - sizes S, M, L - 1.8°

Option

Gear, Brake, Controller, Encoder

Pin configuration

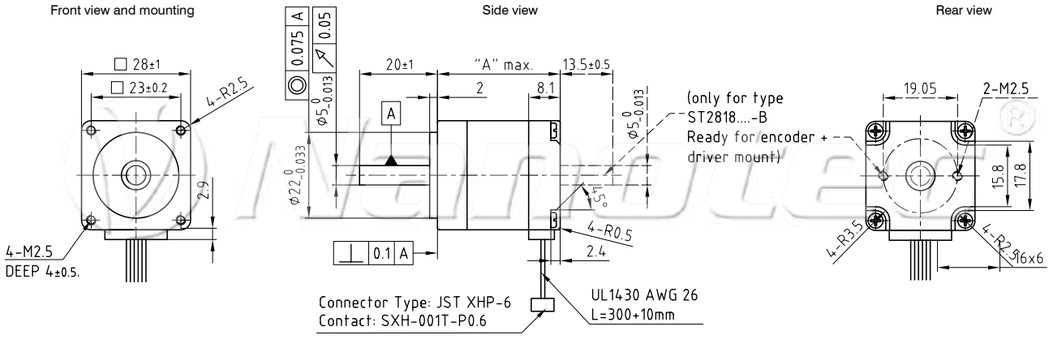


Order identifier

ST 2818 S 1006 -(A)

A = one shaft end
B = two shaft ends for encoder or brake

Outline drawing (in mm)



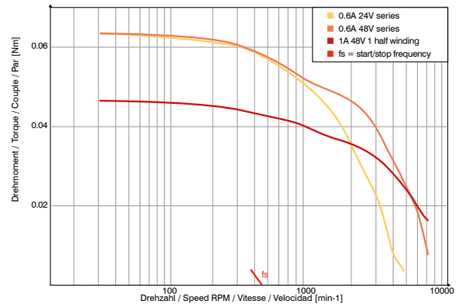
Available versions (others on request)

Type	Current per winding A/winding	Holding torque Ncm	Resistance per winding Ohm/winding	Inductance per winding mH/winding	Rotor inertia torque gcm²	Weight kg	Length "A" mm
ST2818S1006	0.95	4.3	2.8	1.0	9	0.110	32
ST2818M1006	0.95	7.5	3.4	1.2	12	0.176	45
ST2818L1006	0.95	9.0	4.6	1.4	18	0.250	51
ST2818L1404	1.40	11.7	2.3	1.8	18	0.250	51

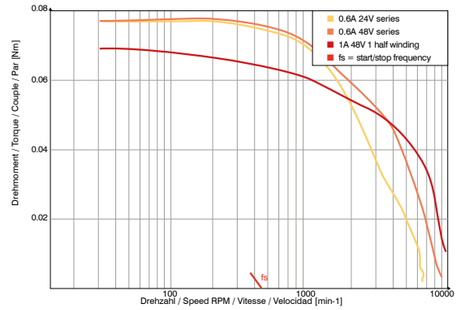
All data refer to 1 half of the winding or unipolar!

Speed/torque curves

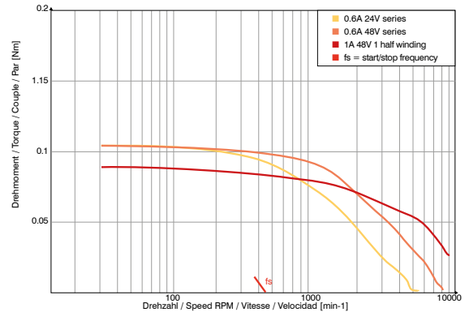
ST2818S1006



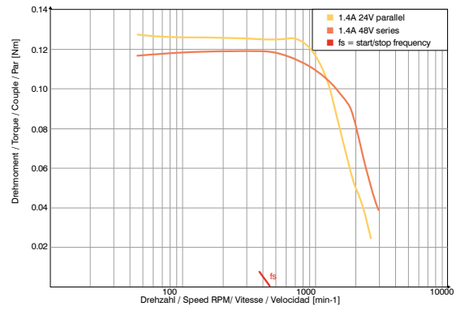
ST2818M1006



ST2818L1006



ST2818L1404

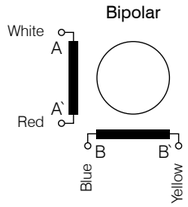


Type ST3518 - sizes S, M, L - 1.8°

Option

Controller Encoder

Pin configuration

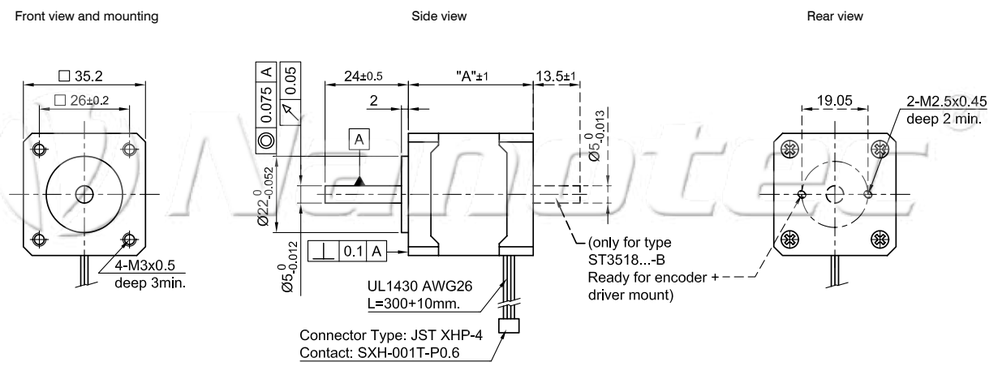


Order identifier

ST 3518 S 0804 -A

A = one shaft end
B = two shaft ends for encoder

Outline drawing (in mm)



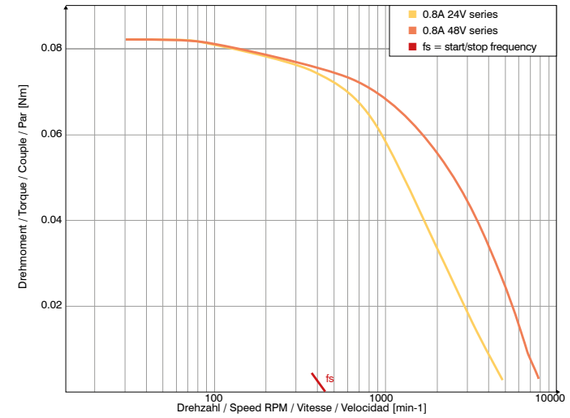
Available versions (others on request)

Type	Current per winding A/winding	Holding torque Ncm	Resistance per winding Ohm/winding	Inductance per winding mH/winding	Rotor inertia torque g cm²	Weight kg	Length "A" mm
ST3518S0804	0.8	7.0	4.0	2.3	10	0.15	26.0
ST3518M1004	1.0	14.0	2.7	4.3	14	0.18	36.0
ST3518L1204	1.2	23.0	3.4	2.8	43	0.30	52.0

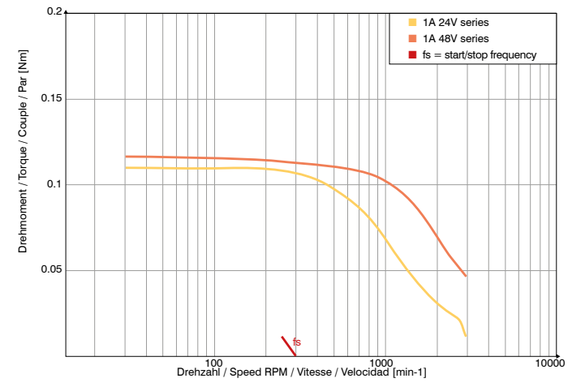
All data refer to 1 half of the winding or unipolar!

Speed/torque curves

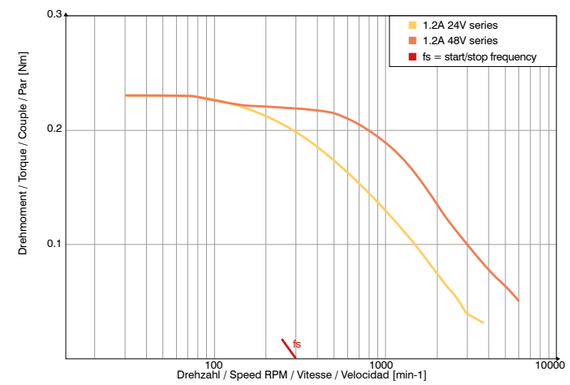
ST3518S0804



ST3518M1004



ST3518L1204

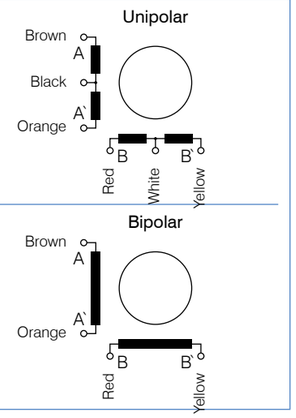


Type ST4209 - size X, S, M, L - 0.9°

Option

Gear, Brake, Controller, Encoder

Pin configuration

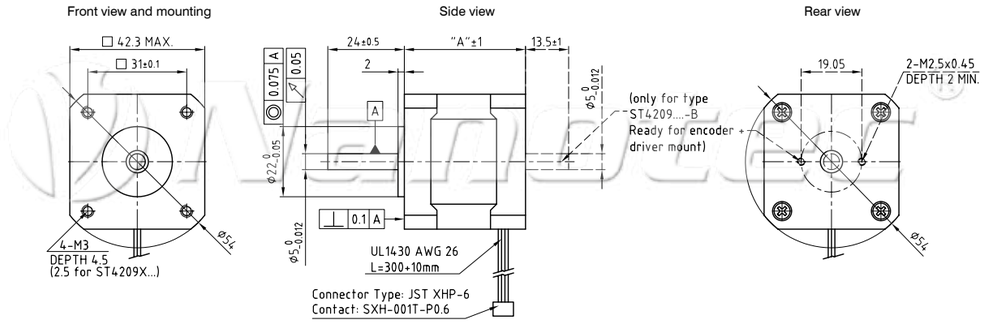


Order identifier

ST 4209 S 1006 - (A)

A = one shaft end
B = two shaft ends for encoder or brake

Outline drawing (in mm)

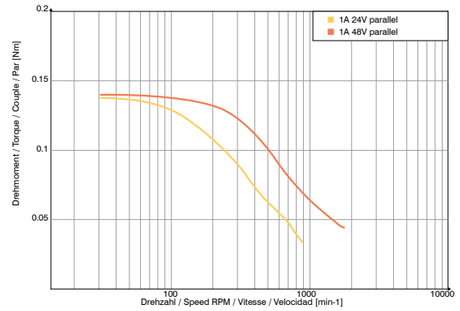


Available versions (others on request)							
Type	**Current per winding** A/winding	**Holding torque** Ncm	**Resistance per winding** Ohm/winding	**Inductance per winding** mH/winding	**Rotor inertia torque** g cm²	**Weight** kg	**Length "A"** mm
ST4209X1004	1.00	17.0	8.70	18.0	20	0.15	22.0
ST4209S0404	0.42	7.6	13.00	7.5	35	0.22	33.5
ST4209S1006	0.95	15.0	4.20	4.0	35	0.22	33.5
ST4209S1404	1.33	22.0	2.10	5.2	35	0.22	33.5
ST4209M1206	1.20	25.0	3.30	4.0	54	0.28	39.5
ST4209M1704	1.68	36.0	1.65	4.0	54	0.28	39.5
ST4209L1206	1.20	31.0	3.30	4.8	68	0.35	47.5
ST4209L1704	1.68	44.0	1.65	5.0	68	0.35	47.5

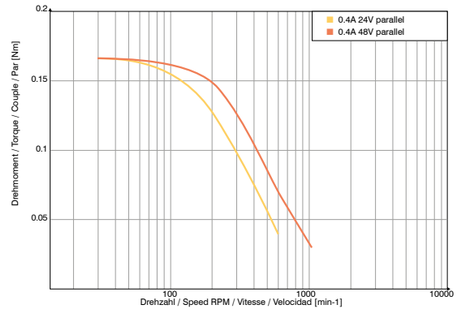
All data refer to 1 half of the winding or unipolar!

Speed/torque curves

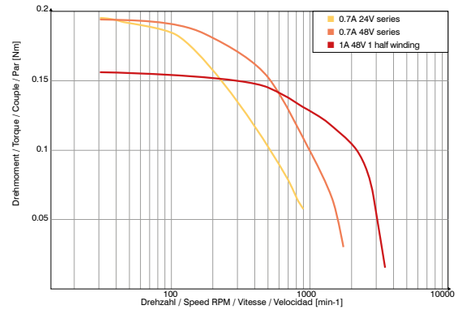
ST4209X1004



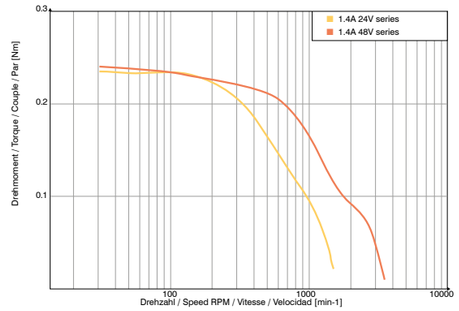
ST4209S0404



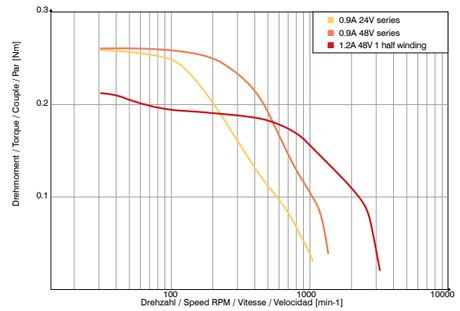
ST4209S1006



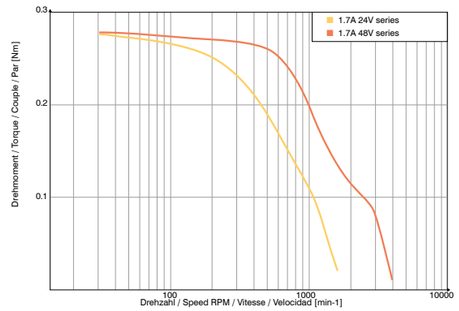
ST4209S1404



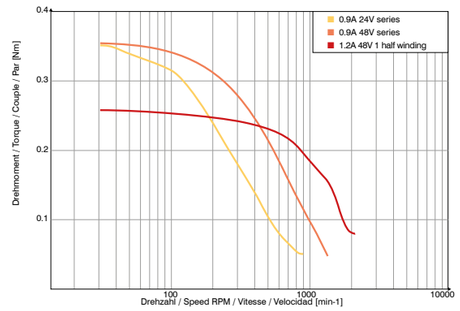
ST4209M1206



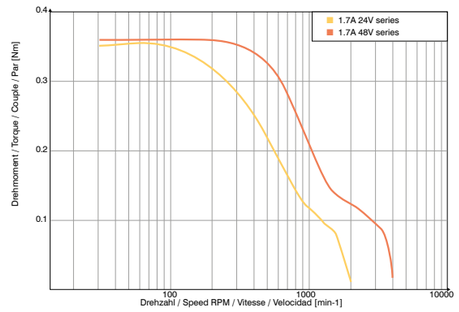
ST4209M1704



ST4209L1206



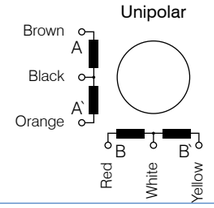
ST4209L1704

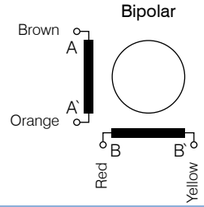


Type ST4118 - sizes X, S, M, L, D - 1.8

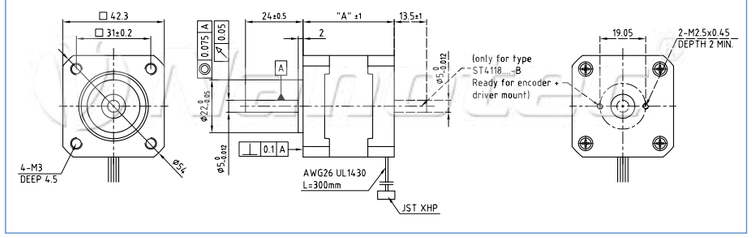
Option

Pin configuration





Outline drawing (in mm)



Order identifier

ST 4118 S 1404 -A

A = one shaft end
B = two shaft ends for encoder or brake

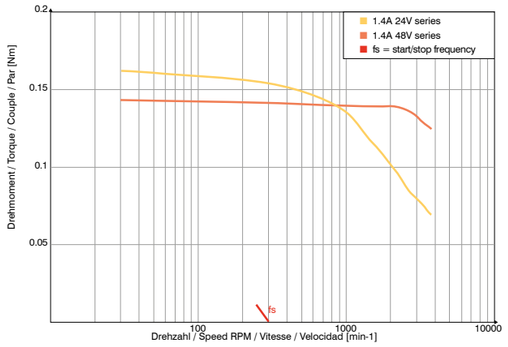
Available versions (others on request)

Type	Current per winding A/winding	Holding torque Ncm	Resistance per winding Ohm/winding	Inductance per winding mH/winding	Rotor inertia torque g cm²	Weight kg	Length "A" mm
ST4118X0404	0.40	17	24.00	36.00	20	0.15	26
ST4118X1404	1.40	9.0	2.00	1.60	20	0.15	26
ST4118S0206	0.22	15.0	75.00	53.00	38	0.20	31
ST4118S0406	0.35	16.0	30.00	21.70	38	0.20	31
ST4118S0706	0.70	16.0	7.60	6.80	38	0.20	31
ST4118S1006	0.95	15.0	3.90	2.80	38	0.20	31
ST4118S1404	1.40	20.0	2.00	3.60	38	0.20	31
ST4118M0406	0.40	28.0	30.00	25.00	57	0.24	38
ST4118M0706	0.70	28.0	9.50	8.00	57	0.24	38
ST4118M0906	0.90	28.0	5.70	6.80	57	0.24	38
ST4118M1206	1.20	28.0	3.10	2.90	57	0.24	38
ST4118M1404	1.40	24.0	1.20	1.70	57	0.24	38
ST4118M1804	1.80	28.0	1.10	1.85	57	0.24	38
ST4118L0804	0.80	50.0	9.30	17.00	82	0.34	49
ST4118L1206	1.20	35.0	3.30	4.30	82	0.34	49
ST4118L1804	1.80	50.0	1.75	3.30	82	0.34	49
ST4118L3004	3.00	50.0	0.63	1.03	82	0.34	49
ST4118D1804	1.80	80.0	3.00	7.00	102	0.50	60
ST4118D3004	3.00	80.0	1.10	2.70	102	0.50	60

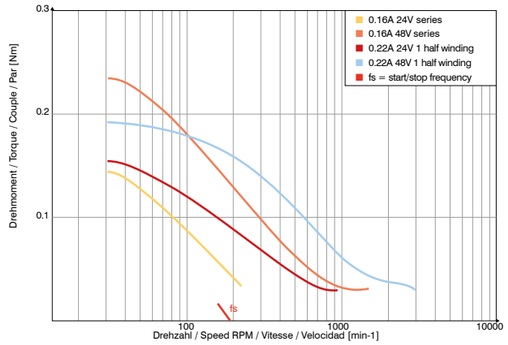
All data refer to 1 half of the winding or unipolar!

Speed/torque curves

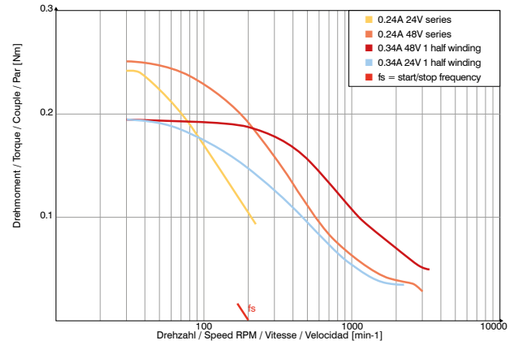
ST4118X1404



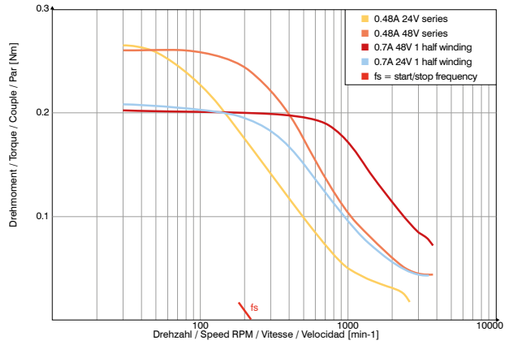
ST4118S0206



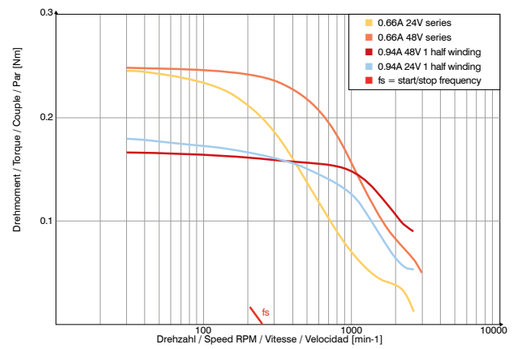
ST4118S0406



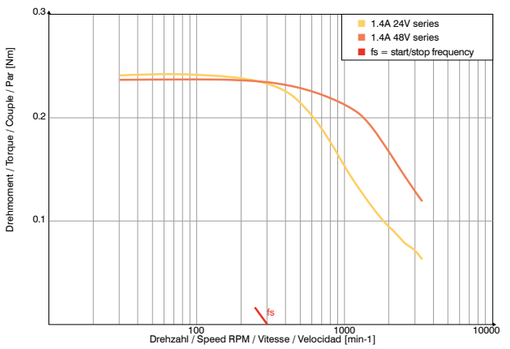
ST4118S0706



ST4118S1006

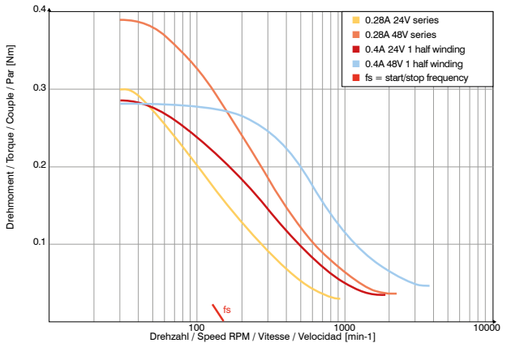


ST4118S1404

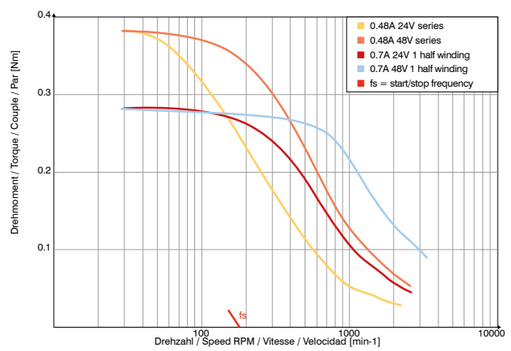


Speed/torque curves

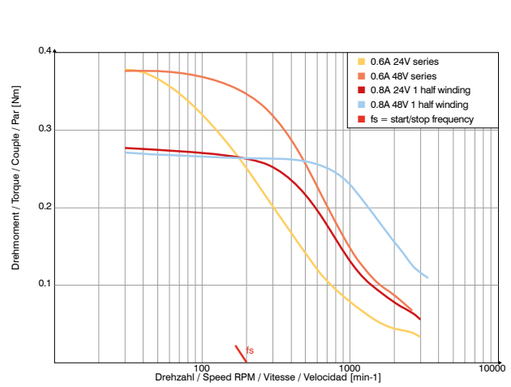
ST4118M0406



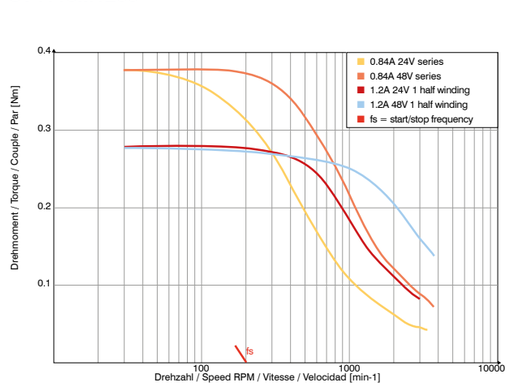
ST4118M0706



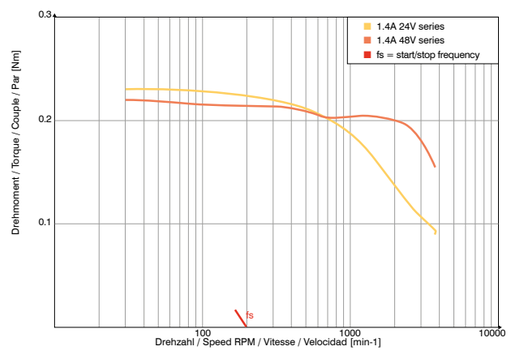
ST4118M0906



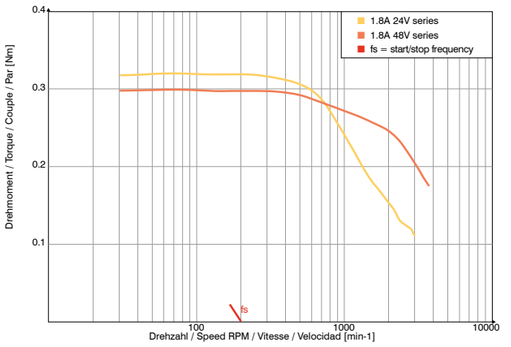
ST4118M1206



ST4118M1404

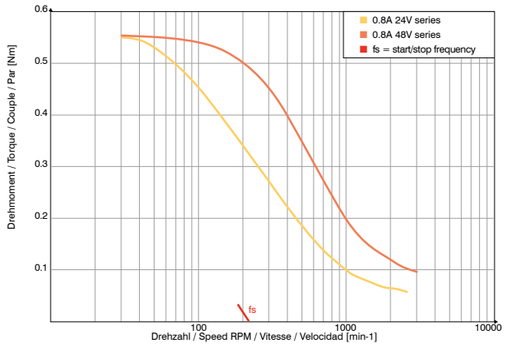


ST4118M1804

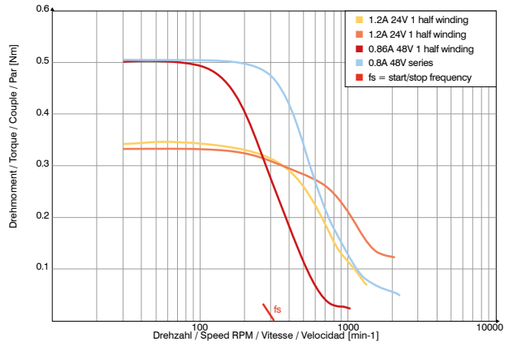


Speed/torque curves

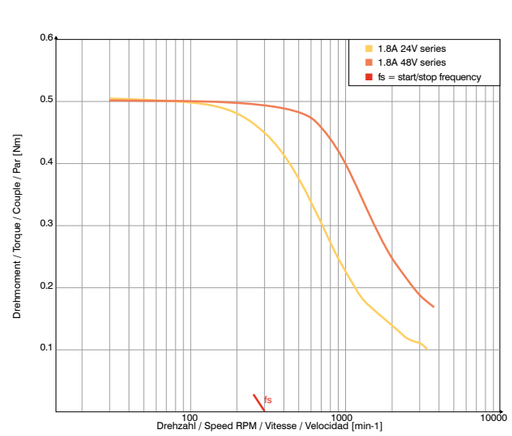
ST4118L0804



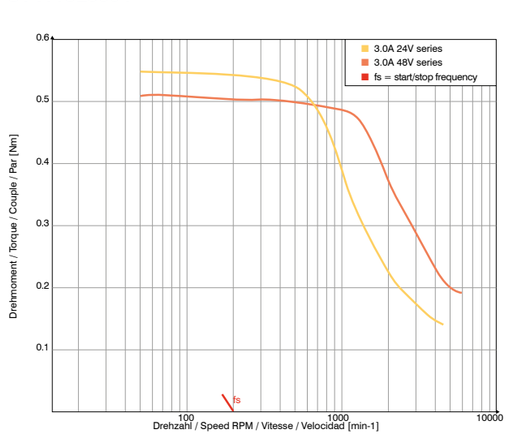
ST4118L1206



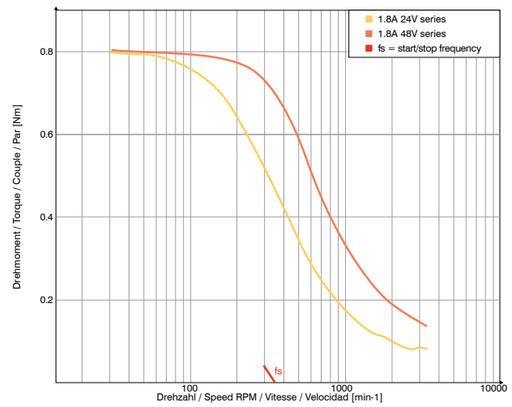
ST4118L1804



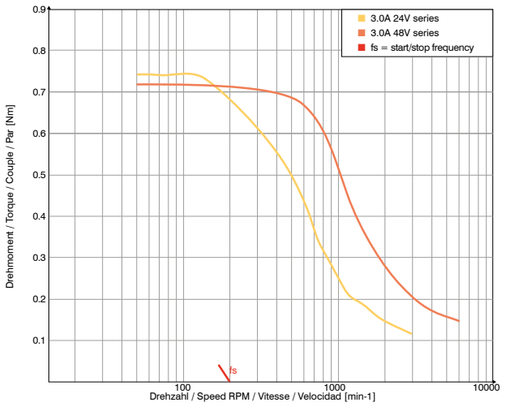
ST4118L3004



ST4118D1804



ST4118D3004

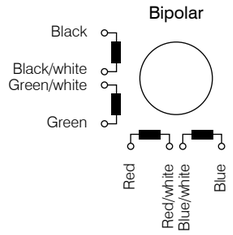


Type ST5909 - size X, M, L - 0.9°

Option

Gear, Brake, Controller, Encoder

Pin configuration

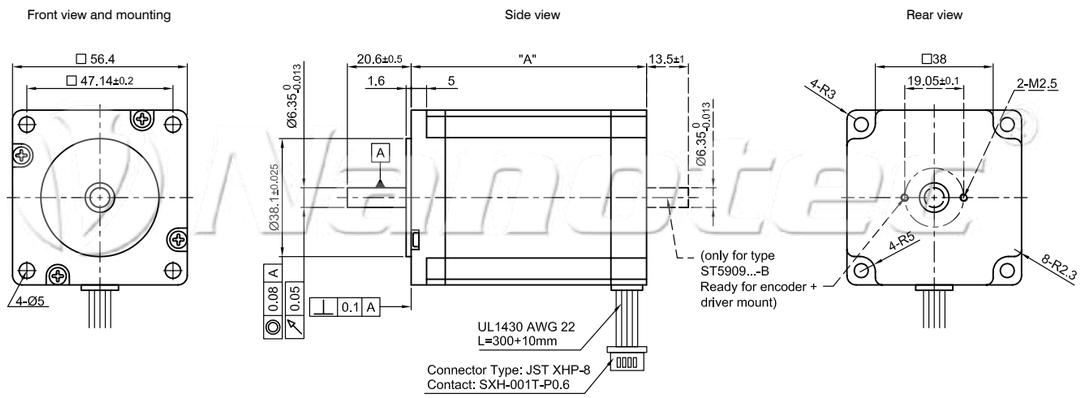


Order identifier

ST 5909M2008 -(A)

A = one shaft end
B = two shaft ends for encoder or brake

Outline drawing (in mm)



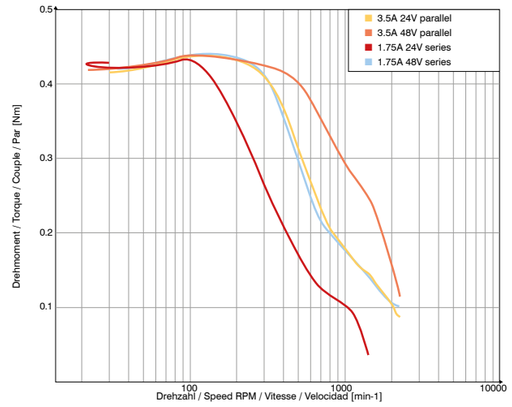
Available versions (others on request)

Type	Current per winding A/winding	Holding torque Ncm	Resistance per winding Ohm/winding	Inductance per winding mH/winding	Rotor inertia torque g cm²	Weight kg	Length "A" mm
ST5909X2508	2.5	43	0.85	1.6	120	0.45	41
ST5909S1008	1.0	72	6.60	13	275	0.65	51
ST5909M2008	2.0	74	1.80	4.5	300	0.70	56
ST5909L1008	1.0	140	8.60	23.0	480	1.00	76
ST5909L2008	2.0	140	2.40	6.7	480	1.00	76
ST5909L3008	3.0	140	1.00	2.6	480	1.00	76

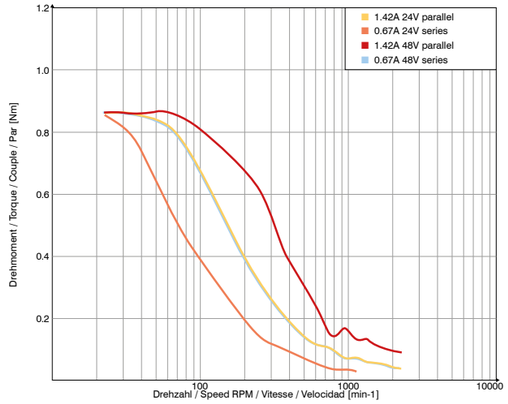
All data refer to 1 half of the winding or unipolar!

Speed/torque curves

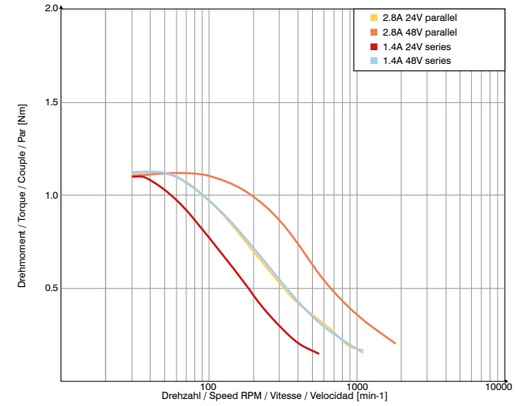
ST5909X2508



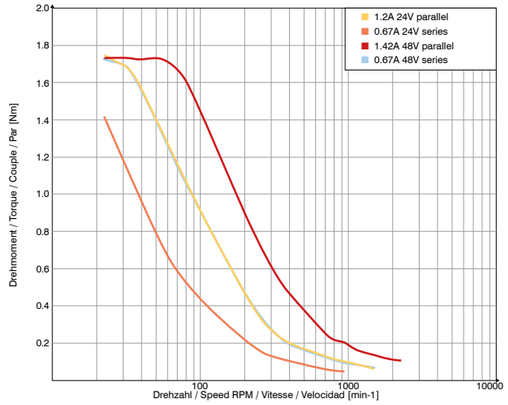
ST5909S1008



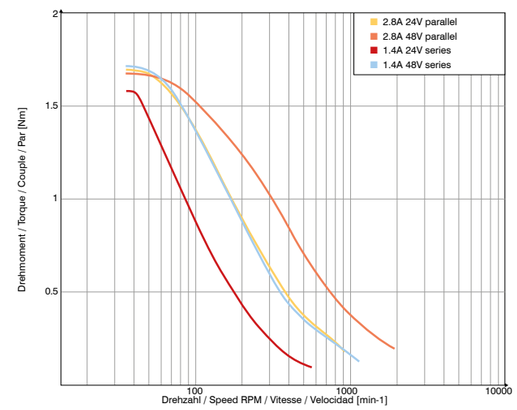
ST5909M2008



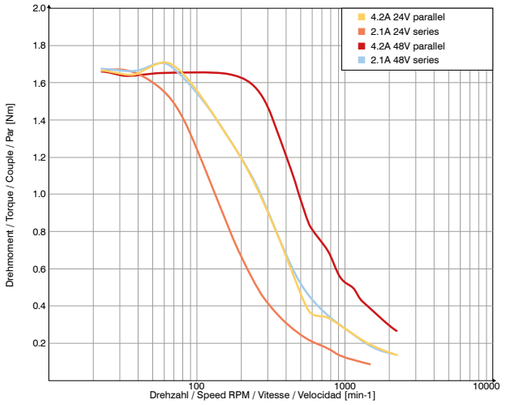
ST5909L1008



ST5909L2008



ST5909L3008



Type ST5918 - size X, S, M, L, D - 1.8°

Option

Gear, Brake, Controller, Encoder

Pin configuration

ST5918X-L — Bipolar

Black
Black/white
Green/white
Green

Red
Red/white
Blue/white
Blue

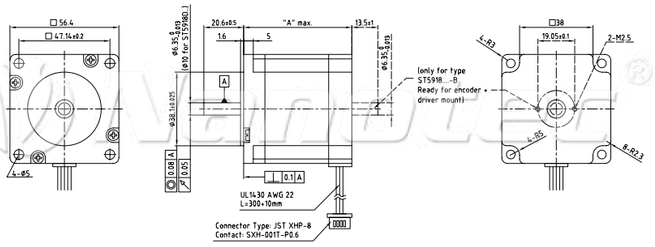
ST5918D — Bipolar

Red
Red/white
Black/white
Black

Green
Green/white
Yellow/white
Yellow

Outline drawing (in mm)

Front view and mounting | Side view | Rear view



Order identifier

ST 5918 X 1008 -A

A = one shaft end
B = two shaft ends for encoder or brake

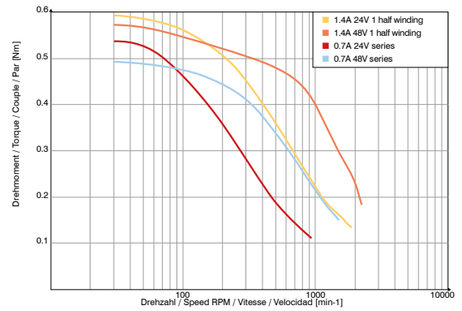
Available versions (others on request)

Type	Current per winding A/winding	Holding torque Ncm	Resistance per winding Ohm/winding	Inductance per winding mH/winding	Rotor inertia torque g cm²	Weight kg	Length "A" mm
ST5918X1008	1.0	38	5.00	5.40	135	0.49	41
ST5918X2008	2.0	38	1.20	1.30	135	0.49	41
ST5918X3008	3.0	38	0.50	0.54	135	0.49	41
ST5918S1008	1.0	65	6.20	9.70	275	0.65	51
ST5918S2008	2.0	60	1.50	2.60	275	0.65	51
ST5918S3008	3.0	65	0.72	1.10	275	0.65	51
ST5918M1008	1.0	74	6.90	14.0	300	0.70	56
ST5918M2008	2.0	74	1.70	3.60	300	0.70	56
ST5918M3008	3.0	80	0.70	1.30	300	0.70	56
ST5918L1008	1.0	120	8.80	19.0	480	1.00	76
ST5918L2008	2.0	140	2.40	5.10	480	1.00	76
ST5918L3008	3.0	140	1.00	2.20	480	1.00	76
ST5918L4508	4.5	130	0.50	0.95	480	1.00	76
ST5918D4208	4.2	180	1.00	2.60	650	1.80	115

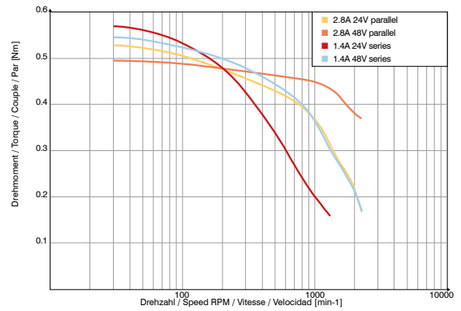
All data refer to 1 half of the winding or unipolar!

Speed/torque curves

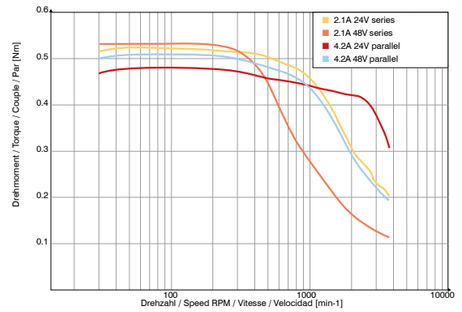
ST5918X1008



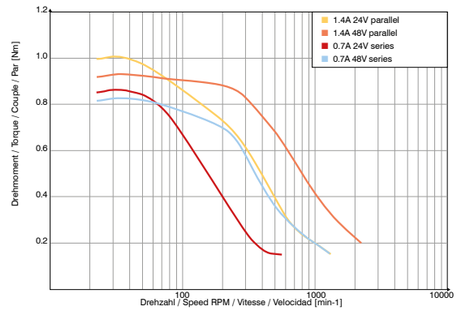
ST5918X2008



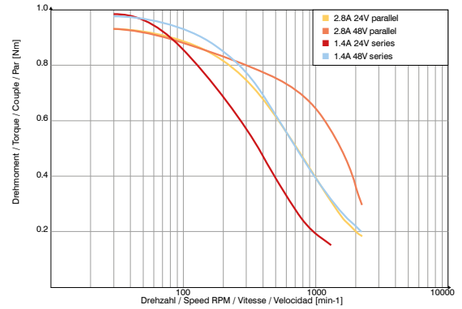
ST5918X3008



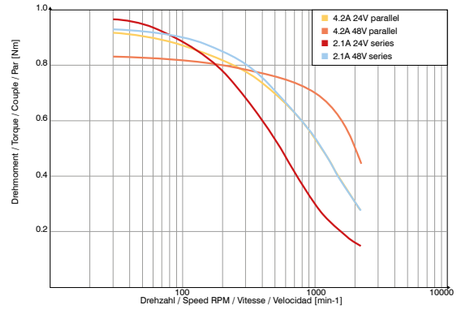
ST5918S1008



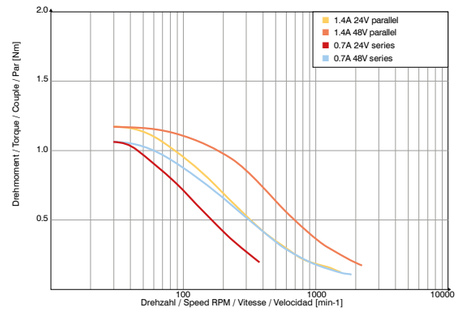
ST5918S2008



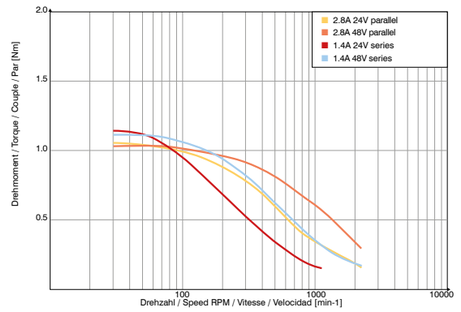
ST5918S3008



ST5918M1008

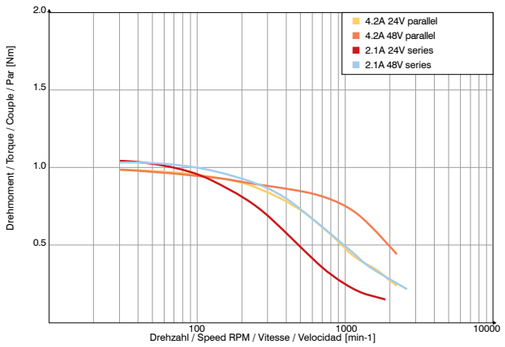


ST5918M2008

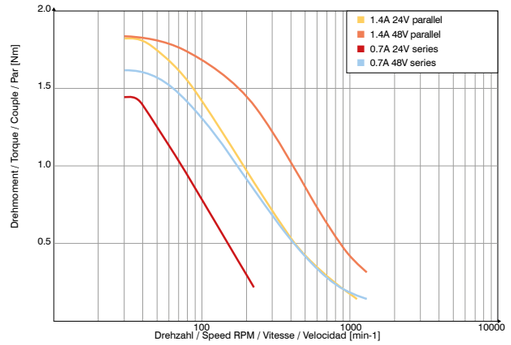


Speed/torque curves

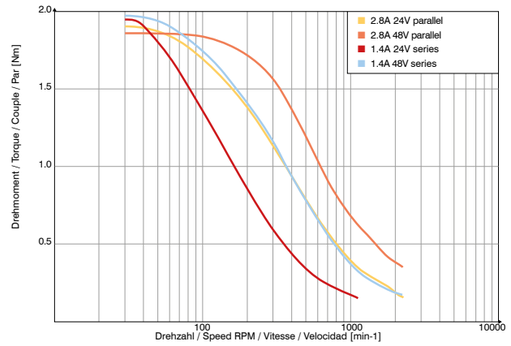
ST5918M3008



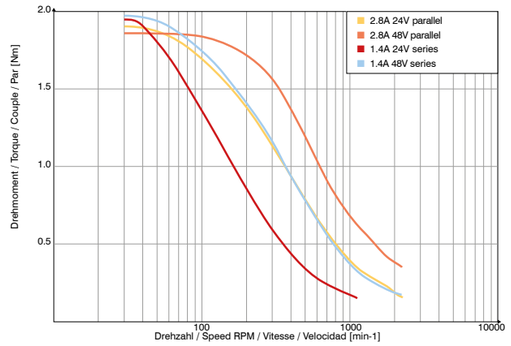
ST5918L1008



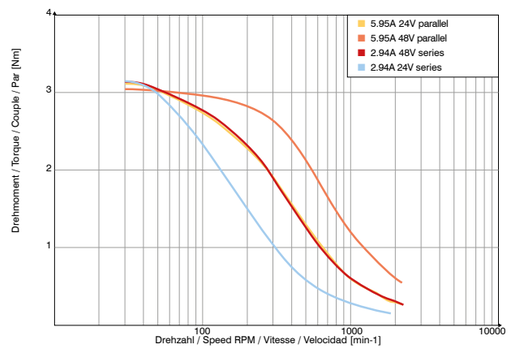
ST5918L2008



ST5918L3008



ST5918D4208



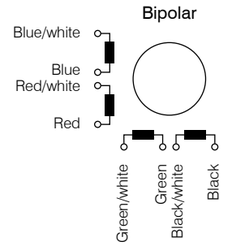
Notes

Type ST6018 - size X, M, K, L, D - 1.8°

Option

Gear, Brake, Controller, Encoder

Pin configuration

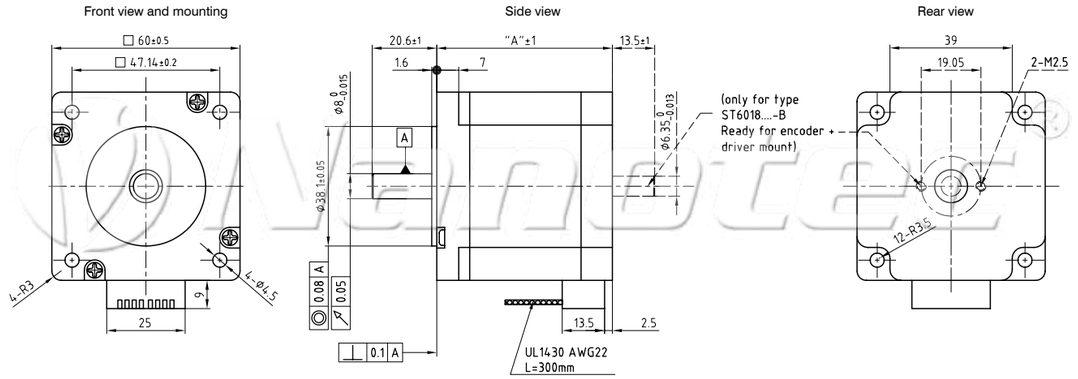


Order identifier

ST 6018 X 2008 -(A)

A = one shaft end
B = two shaft ends for encoder or brake

Outline drawing (in mm)



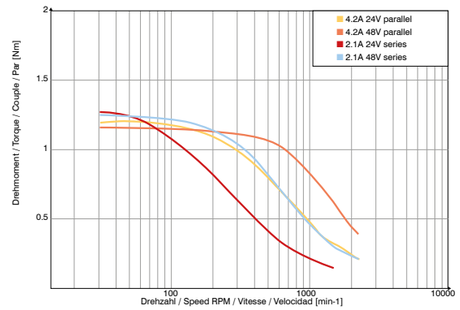
Available versions (others on request)

Type	Current per winding A/winding	Holding torque Ncm	Resistance per winding Ohm/winding	Inductance per winding mH/winding	Rotor inertia torque g cm²	Weight kg	Length "A" mm
ST6018X2008	2.0	75	1.46	1.80	275	0.60	47
ST6018X3008	3.0	78	0.68	0.80	275	0.60	47
ST6018M2008	2.0	138	2.00	5.60	450	0.77	56
ST6018M3008	3.0	117	0.80	1.38	450	0.77	56
ST6018K2008	2.0	150	2.40	4.60	570	1.20	67
ST6018L3008	3.0	250	1.30	3.20	840	1.40	88
ST6018D4508	4.5	283	0.75	1.40	1100	1.90	111

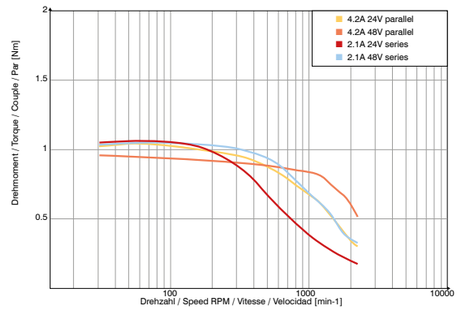
All data refer to 1 half of the winding or unipolar!

Speed/torque curves

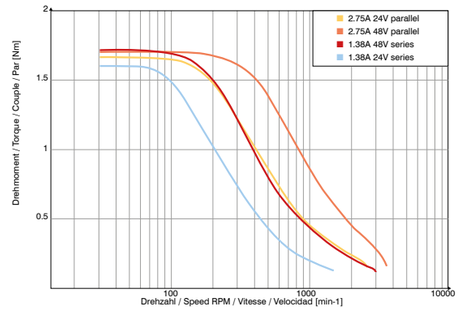
ST6018X2008



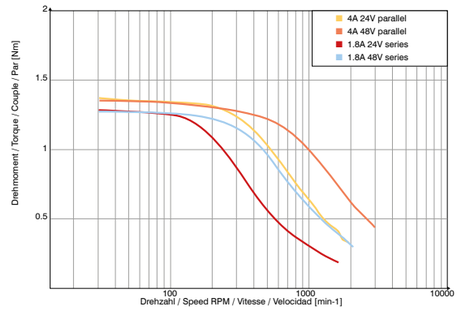
ST6018X3008



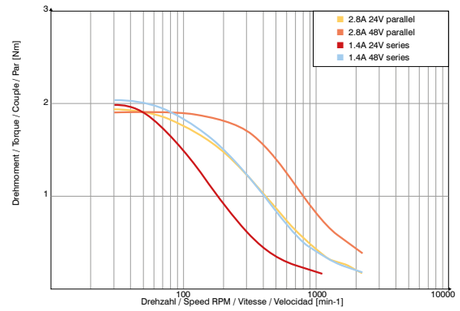
ST6018M2008



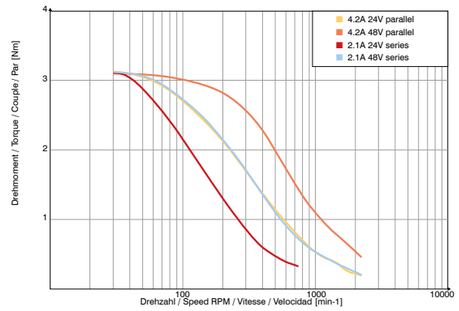
ST6018M3008



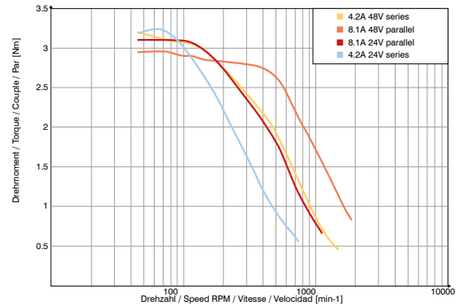
ST6018K2008



ST6018L3008



ST6018D4508

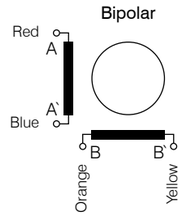


Type ST6318 - ultraflat stepper motor

Option

Controller

Pin configuration

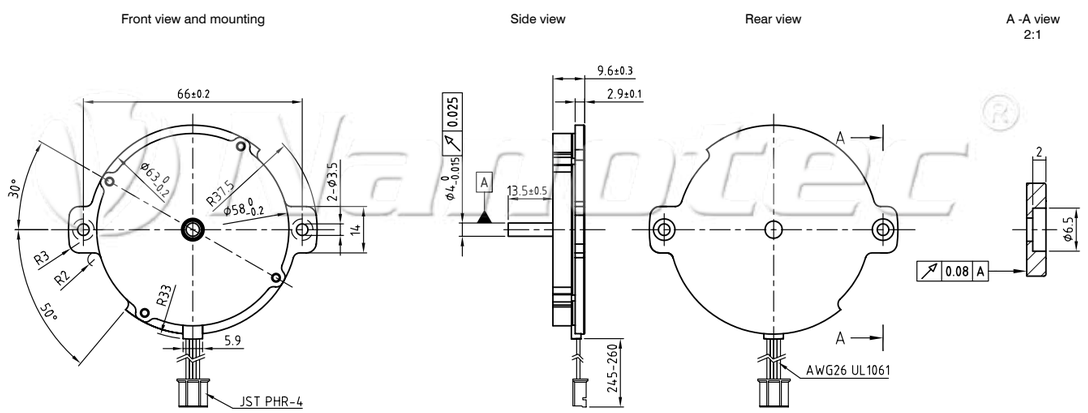


The ultraflat ST6318F1004 high-torque stepper motor with a 1.8° step angle (with microstep down to < 0.02°) supports every design engineer who needs maximum torque with minimal construction height and a high degree of positioning precision. Stable speed behavior for both the slowest speeds and high number of rotations is possible due to the high torque. The implementation benefits are used to an advantage primarily in applications like component feeders in semi-conductor automation, medical laboratory and inspection devices, laser technology, inspection instrument construction, surveillance cameras, etc. Customer-specific designs are possible.

Order identifier

ST 6318 F 1004 - A

Outline drawing (in mm)

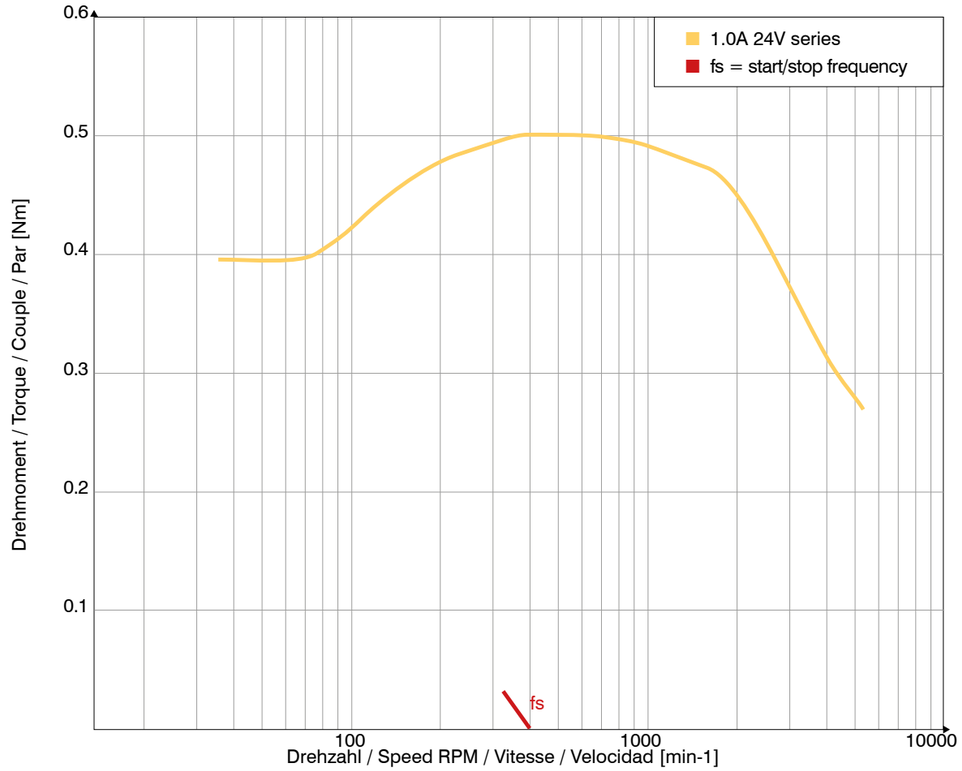


Available versions (others on request)

Type	Current per winding A/winding	Holding torque Ncm	Resistance per winding Ohm/winding	Inductance per winding mH/winding	Rotor inertia torque g cm²	Weight kg	Length "A" mm
ST6318F1004	1.0	6.0	3.8	2.0	16	0.095	9.5

Speed/torque curves

ST6318F1004

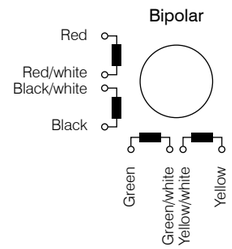


Type ST8918 - sizes S, M, L, D - 1.8°

Option

Gear, Brake, Controller, Encoder

Pin configuration

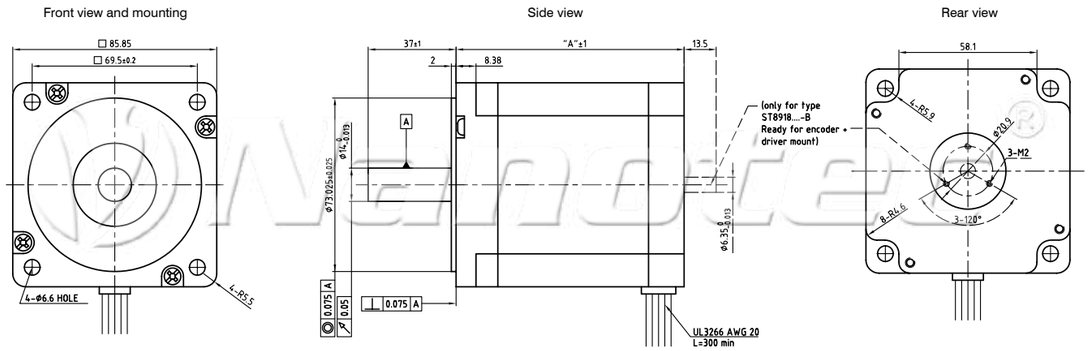


Order identifier

ST 8918 M 6708 -(A)

A = one shaft end
B = two shaft ends for encoder or brake

Outline drawing (in mm)



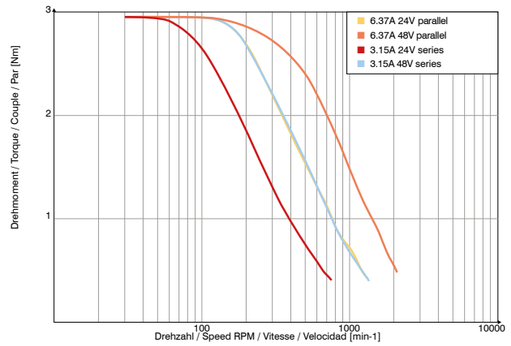
Available versions (others on request)

Type	Current per winding A/winding	Holding torque Ncm	Resistance per winding Ohm/winding	Inductance per winding mH/winding	Rotor inertia torque g cm²	Weight kg	Length "A" mm
ST8918S4508	4.5	250	0.60	1.9	1000	1.70	65
ST8918M4508	4.5	420	0.66	3.0	1900	2.80	96
ST8918M6708	6.7	420	0.45	2.6	1900	2.80	96
ST8918L4508	4.5	660	1.10	6.3	3000	3.95	126
ST8918L6708	6.7	660	0.46	2.7	3000	3.95	126
ST8918D6708	6.7	950	0.75	4.9	4000	5.40	156

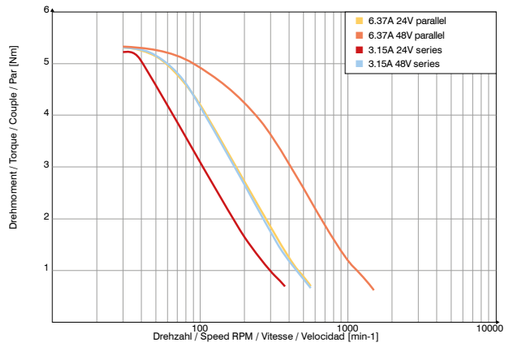
All data refer to 1 half of the winding or unipolar!

Speed/torque curves

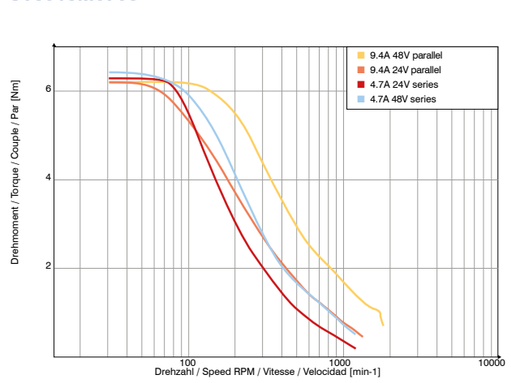
ST8918S4508



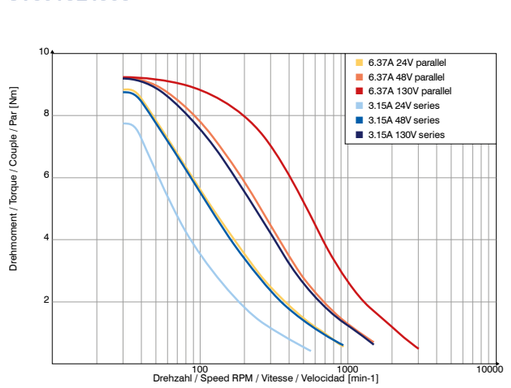
ST8918M4508



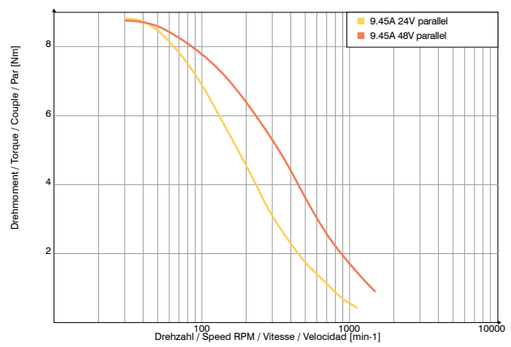
ST8918M6708



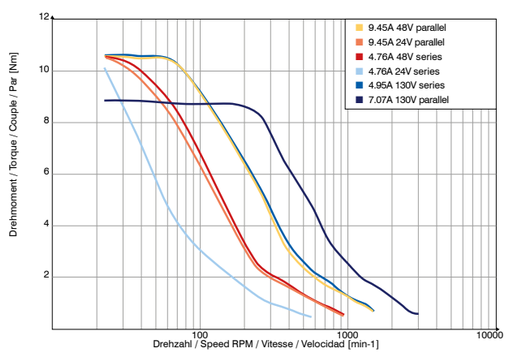
ST8918L4508



ST8918L6708



ST8918D6708

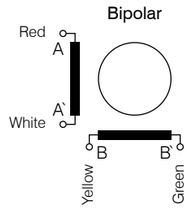


Type ST11018 - sizes S, M, L - 1.8°

Option

Controller Brake Encoder

Pin configuration

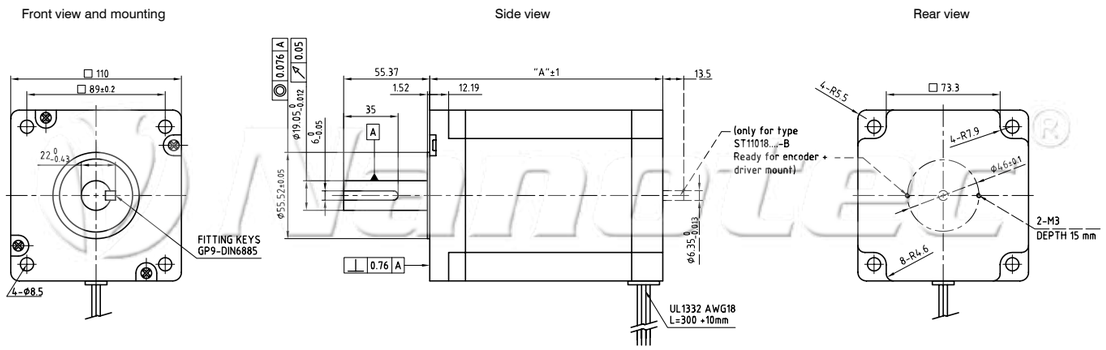


Order identifier

ST 11018 M 6504 -(A)

A = one shaft end
B = two shaft ends
for encoder or brake

Outline drawing (in mm)

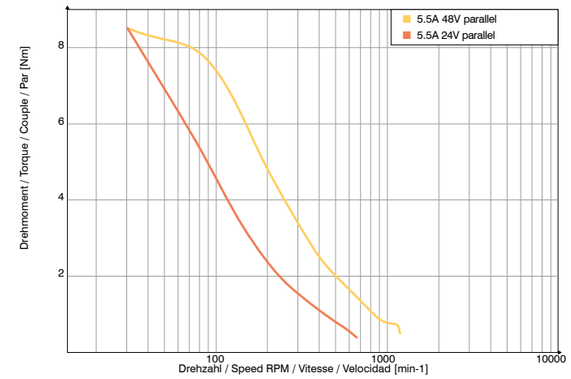


Available versions (others on request)

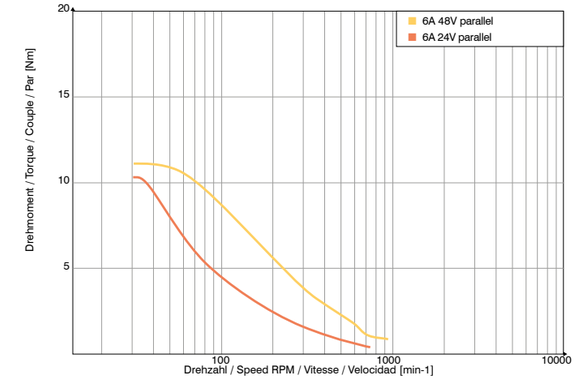
Type	Current per winding A/winding	Holding torque Nm	Resistance per winding Ohm/winding	Inductance per winding mH/winding	Rotor inertia torque g cm²	Weight kg	Length "A" mm
ST11018S5504	5.5	11.7	0.70	9.8	5500	5.0	99
ST11018M6504	6.5	21.0	1.15	15.2	10900	8.4	150
ST11018L8004	8.0	25.0	1.00	17.1	16200	11.7	210

Speed/torque curves

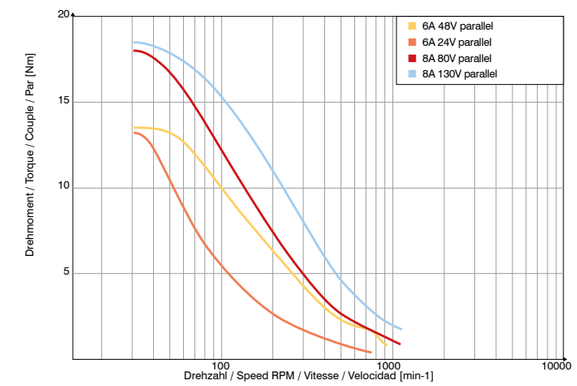
ST11018S5504



ST11018M6504



ST11018L8004



Notes

Stepper motors in protection class IP65

AS2818, AS4118, AS5918 stepper motor with terminal box

Option

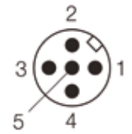
Gear · Brake · Controller · Encoder

Connector configuration

M12 - 5-pin (MOTOR)	
Pin.	assignment
1	A\
2	A
3	B
4	B\
5	Housing

M12 - 8-pin (ENCODER)	
Pin.	assignment
1	A
2	A\
3	B
4	B\
5	GND
6	I\
7	I
8	Vcc
Housing	GND/shielding

M12 connector



M12 connector

M8 - 3-pin (BRAKE)	
Pin	assignment
1	Brake/Vcc (+24V)
3	Brake/GND
4	NC

M8 connector

Order identifier

AS5918S2804 - ○

S = M12 plug connector
without option = with terminal box
E = with encoder
EB = with encoder and brake
ENM24 = with 24V encoder
ENM24B = with 24V encoder and brake

Suitable connection cables:
Motor: ZK-M12-5-xx
Encoder: ZK-M12-8-xx
Brake: ZK-M8-3-xx
For further information, see section on "Cables"

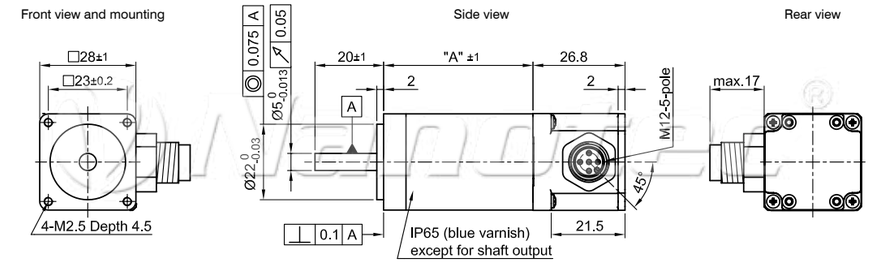
Machine-compatible stepper motors with up to protection class IP 65 (aside from the shaft outlet) offer a thorough drive concept. They are electrically and mechanically interchangeable with standard motors due to having the same flange dimensions. The terminal box on the back only makes the motors slightly longer. In particular, they are distinguished by a large power and application range as well as by their high availability.

Available versions (others on request)

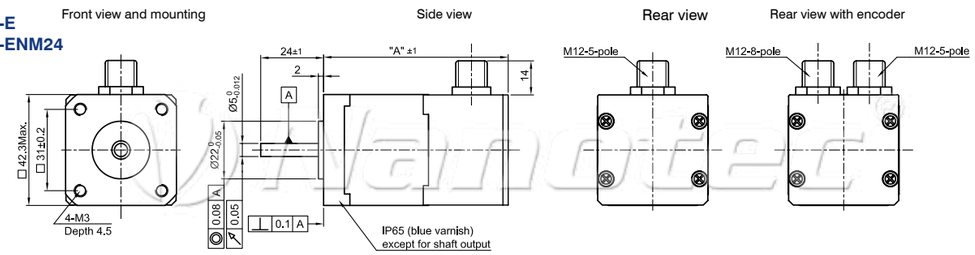
Type	Current	Holding torque	Resistance	Inductance	Rotor inertia	Weight	Length "A"	Encoder Pulses/rev. Signal voltage	Brake
	A/phase	Ncm	Ohm/phase	mH	g cm²	kg	mm		Nm
AS2818S0604	0.67	7.1	5.60	4.0	9	0.13	51.0		
AS2818L0604	0.67	12.7	9.20	5.6	18	0.22	70.3		
AS4118L1804	1.80	50	1.75	3.3	82	0.34	70.4		
AS4118L1804-E	1.80	50	1.75	3.3	82	0.34	70.4	500/rev., 5V	
AS4118L1804-EB	1.80	50	1.75	3.3	82	0.34	106.4	500/rev., 5V	0.4
AS4118L1804-ENM24	1.80	50	1.75	3.3	82	0.34	70.4	1024/rev., 24V	
AS4118L1804-ENM24B	1.80	50	1.75	3.3	82	0.34	106.4	1024/rev., 24V	0.4
AS5918S2804	2.83	85	0.75	2.6	230	0.80	73.0		
AS5918S2804-E	2.83	85	0.75	2.6	230	0.80	73.0	500/rev., 5V	
AS5918M2804	2.82	105	0.85	3.6	300	0.85	77.0		
AS5918M2804-E	2.82	105	0.85	3.6	300	0.85	77.0	500/rev., 5V	
AS5918L4204	4.20	198	0.50	1.9	480	1.14	98.0		
AS5918L4204-E	4.20	198	0.50	1.9	480	1.14	98.0	500/rev., 5V	
AS5918L4204-EB	4.20	198	0.50	1.9	480	1.14	138.0	500/rev., 5V	1
AS5918L4204-ENM24	4.20	198	0.50	1.9	480	1.14	98.0	1024/rev., 5V	
AS5918L4204-ENM24B	4.20	198	0.50	1.9	480	1.14	138.0	1024/rev., 5V	1

Outline drawing AS28, AS41, AS59 for flange size 28, 42 and 56

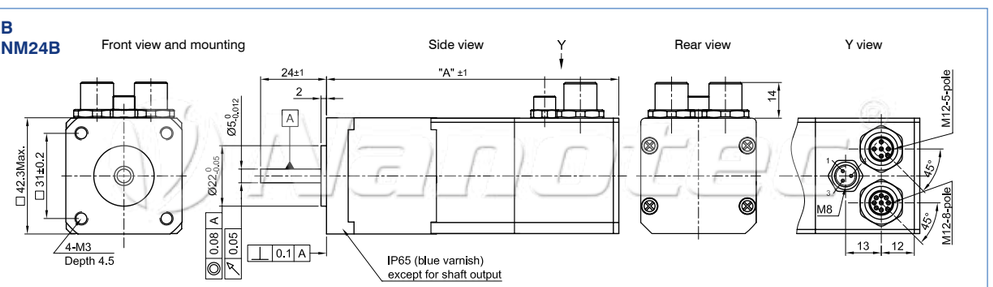
AS2818



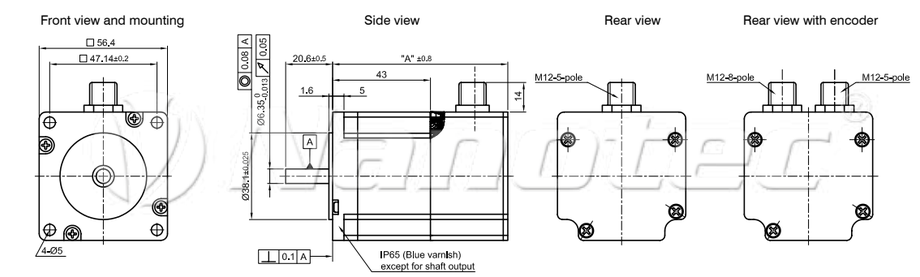
AS4118L1804
AS4118L1804-E
AS4118L1804-ENM24



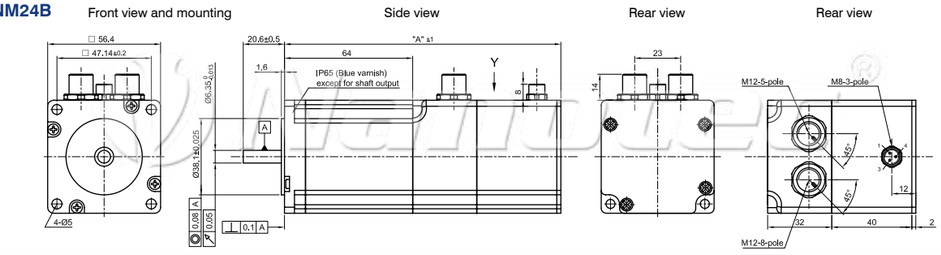
AS4118L1804-EB
AS4118L1804-ENM24B



AS5918
AS5918...-E
AS5918...-ENM24

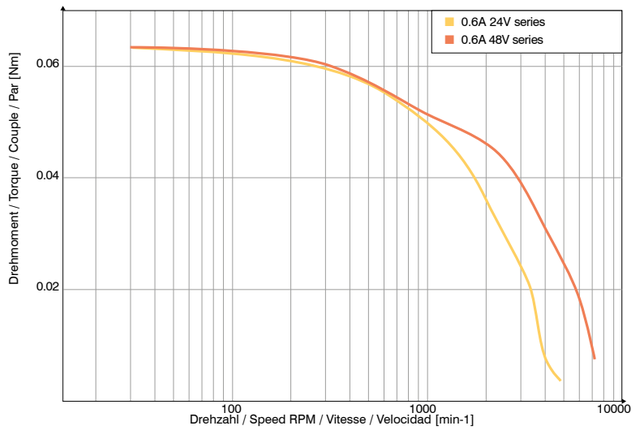


AS5918L4204-EB
AS5918L4204-ENM24B

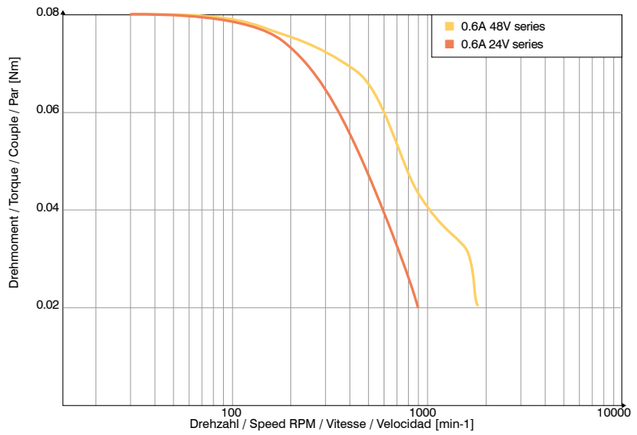


Speed/torque curves

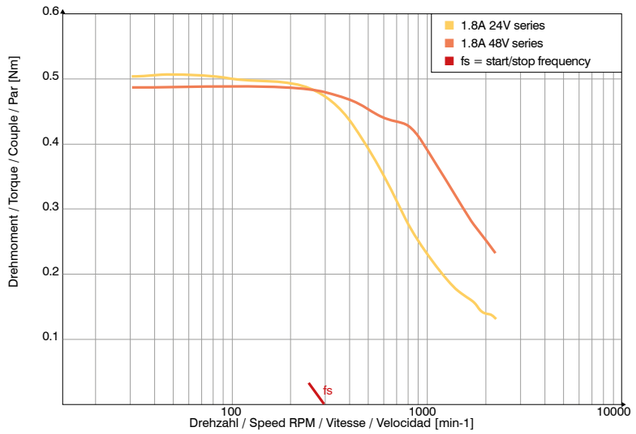
AS2818S0604



AS2818L0604

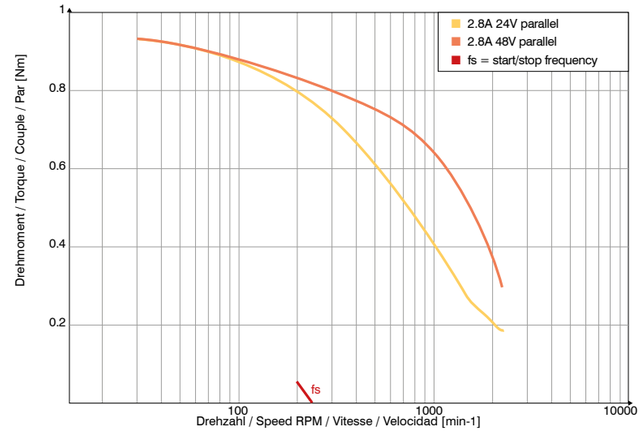


AS4118L1804

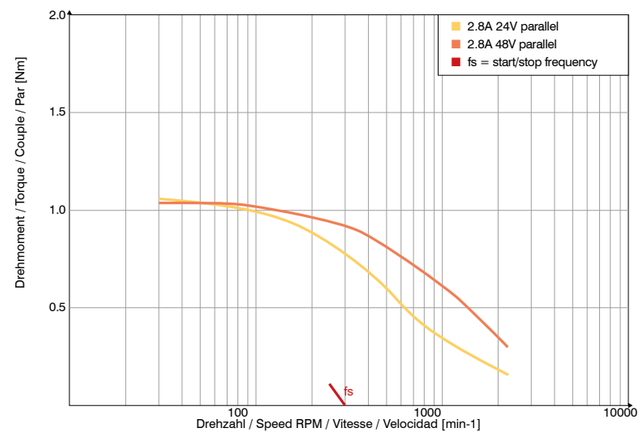


Speed/torque curves

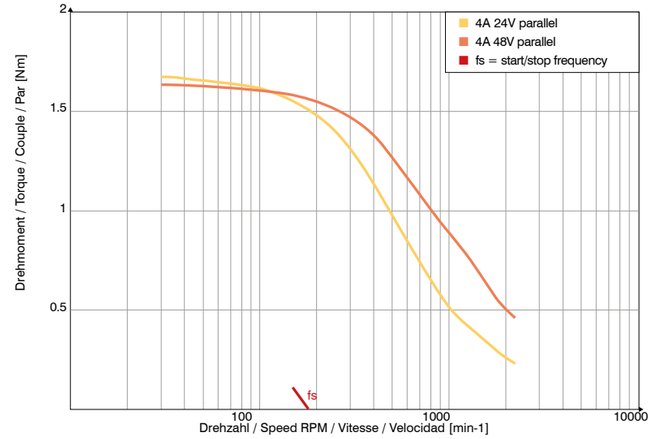
AS5918S2804



AS5918M2804



AS5918L4204



AP8918 stepper motor with terminal box

Option

Gear, Encoder, Controller

Cable connection

Cable connector M16 (MOTOR)		
Cable no.	**Color**	**assignment**
1	BLACK (MARKED WITH CABLE NO.)	A
2		A\
3		B
4		B\
5		Housing

Cable connector M16 (ENCODER)	
Color	**assignment**
White	A
Brown	A\
Green	B
Yellow	B\
Gray	GND
Pink	I\
Blue	I
Red	Vcc

Order identifier

A P 8918M6404 -

P = PG gland

without option = with terminal box

E = with encoder

Through their electrical and mechanical interchangeability with the standard motors, the machine-compliant stepper motors up to a protection class of IP 65 (except for shaft output) offer a consistent drive concept.
The extremely compact motor with terminal box is only 16 mm longer than standard motors.

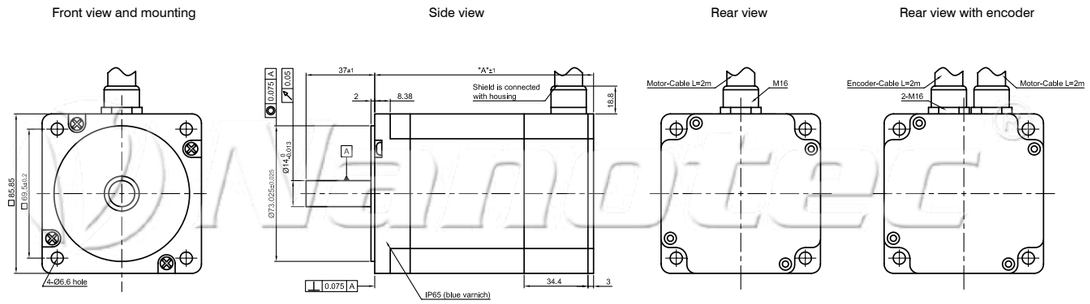
Pre-assembled cables permit rapid and error-free wiring and commissioning when used in extreme environment conditions and reduce the amount of work in suppression and EMC activities.

The standard motors are delivered with a shielded 5-pin cable and a shielded 8-pin cable for the encoder. The cable length is 2 m for each.

Encoder:
500 pulses / revolution, line driver and index (a pulse at 360°), 5 V TTL signal (other encoders available on request)

Outline drawing (mm) AP8918 for flange size 86

AP8918

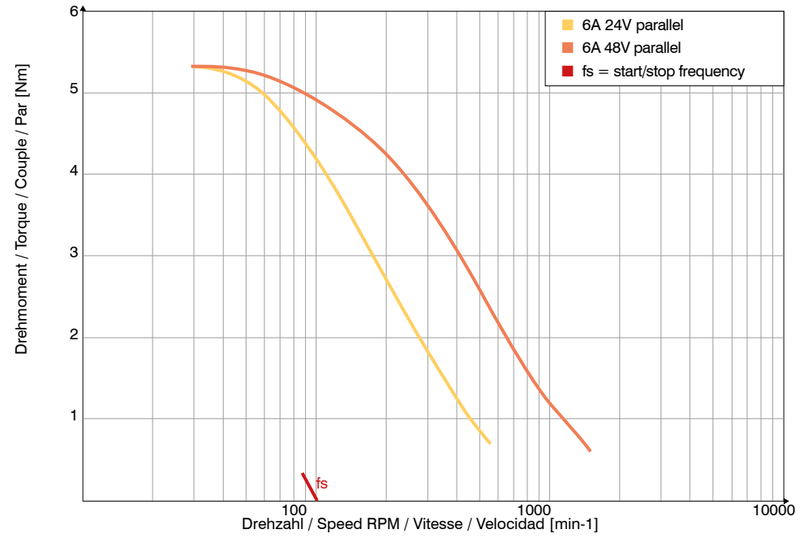


Available versions (others on request)

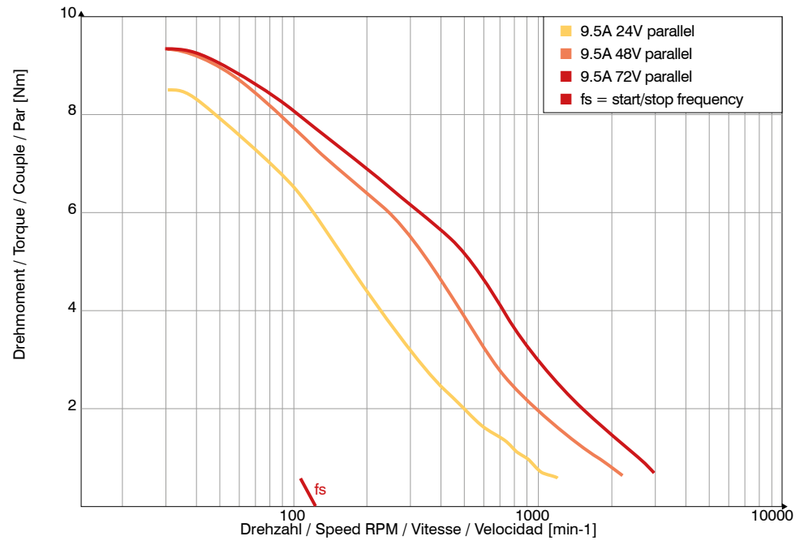
Type	Current	Holding torque	Resistance	Inductance	Rotor inertia torque	Weight	Length "A"	Encoder
	A/phase	Ncm	Ohm/phase	mH	g cm²	kg	mm	Pulses/rev.
AP8918M6404	6.4	594	0.33	3.00	2700	3.4	118.0	
AP8918M6404-E	6.4	594	0.33	3.00	2700	3.5	118.0	500
AP8918L9504	9.5	933	0.23	2.70	3000	4.6	148.0	
AP8918L9504-E	9.5	933	0.23	2.70	3000	4.7	148.0	500

Speed/torque curves

AP8918M6404



AP8918L9504



Brushless DC motors

General information on brushless DC motors

Advantages

- Significantly higher efficiency and power density than induction motors (by approx. 35% volume and weight reduction at the same load)
- Longest expected service life and quiet running in brushless technology with precision ball race
- thanks to the linear torque curve permits an exceptionally large speed range at full motor load and therefore improved matching to the required load conditions
- Reduced electrical interference emission along with excellent thermal properties
- Mechanically interchangeable with stepper motors, and hence less construction expense and greater parts variety

Affordable electronically commutated 3-phase brushless motors (EC motors) are particularly well suited for applications that need smooth running and long service life. The high permanently energized magnets allow high acceleration and speeds of up to 14,000 rpm with exceptional efficiency. The rotor position is reported electronically using three Hall sensors offset by 60° or 120°. Optional encoders up to 2000 pulses/rev. allow high-resolution position controlling.

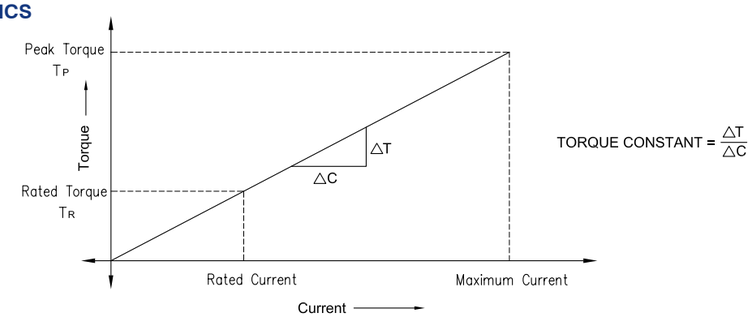
Technical data

Peak torque: 15-630 Ncm

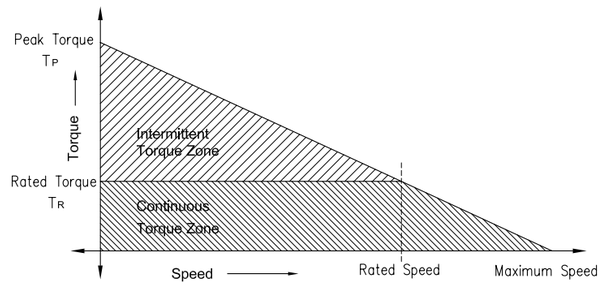
Operating voltage: DC 17-48 V
Nominal speed: 3000-14000 rpm
Temperature range: -10° to 50°

Properties

TORQUE/CURRENT CHARACTERISTICS



TORQUE/SPEED CHARACTERISTICS



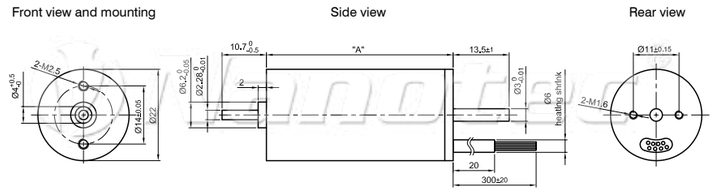
Brushless DC motors - 3.8 W to 16 W

Option

Gear · Encoder · Controller

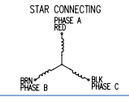
Outline drawing (mm)

DB22



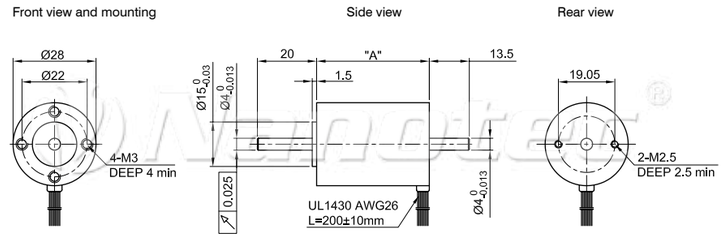
Pin configuration DB22

DB22	Color	Function
Motor	Red	U
	Brown	V
	Black	W
Hall	Blue	+5 V
	Green	GND
	Red	H1
	Yellow	H2
	Brown	H3



Outline drawing (mm)

DB28

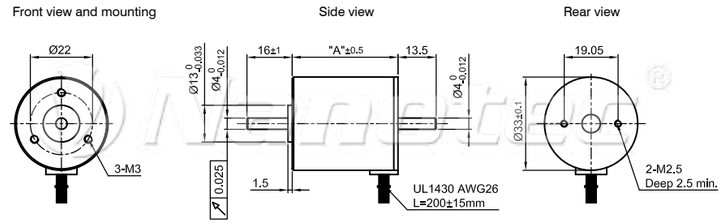


Pin configuration DB28

DB28	Color	Function
Motor	Green	U
	Red	V
	Black	W
Hall	Yellow	+5 V
	White	GND
	Blue	H1
	Orange	H2
	Brown	H3

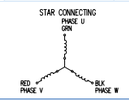
Outline drawing (mm)

DB33



Pin configuration DB33

DB33	Color	Function
Motor	Green	U
	Red	V
	Black	W
Hall	Yellow	+5 V
	Blue	H1
	Orange	H2
	Brown	H3
	White	GND



Available versions (others on request)

Type	Nom. output W	Nom./peak torque Ncm	Nom./peak current A	Nom. voltage/speed V/rpm	torque Constant Ncm/A	Resistance Ohm/winding	Inductance mH/winding	Rotor inertia gcm²	Weight kg	Length "A" mm
DB22M01	3.8	0.8 / 2.1	0.265 / 1.1	24 / 4800	3.02	23.0	6.2	0.66	0.075	45
DB22L02	7.7	2.2 / 5.0	0.62 / 1.5	24 / 3500	3.55	11.80	4.2	1.32	0.120	68
DB28S01	6.0	0.7 / 2.1	0.51 / 2.5	15 / 8000	1.37	8.00	2.5	1.23	0.060	28
DB28M01	14.0	1.4 / 4.2	0.15 / 2.8	24 / 10000	1.60	4.63	1.6	2.12	0.082	38
DB28L01	16.0	5.0 / 15.0	1.0 / 3.0	24 / 3700	5.00	4.20	2.2	5.98	0.280	77
DB33S01	7.0	2.2 / 6.6	0.56 / 1.4	24 / 3000	4.60	12.40	7.0	2.94	0.115	38

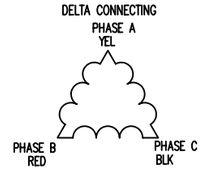
Brushless DC motors - 30 W to 150 W

Option

Gear · Brake · Controller · Encoder

Pin configuration DB42

DB42	Color	Function
Motor	Yellow	U
	Red	V
	Black	W
Hall	Red	+5 V
	Black	GND
	Blue	H1
	White	H2
	Green	H3



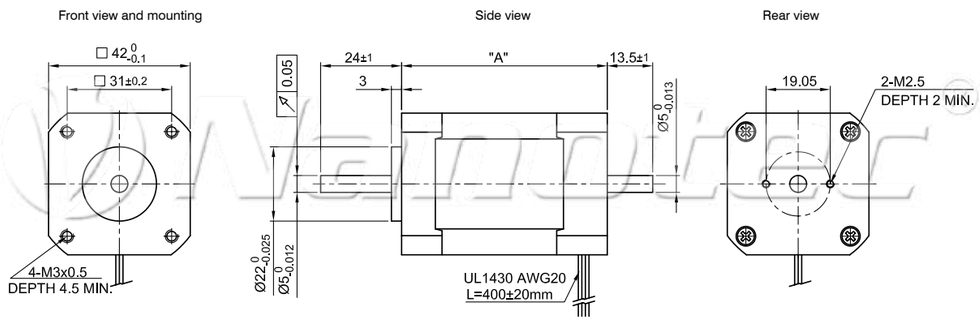
Accessories

Encoder: WEDS...; WEDL... with 500-1000 pulses

Brake: Possible on request.

Outline drawing (mm)

DB42



Available versions (others on request)

Type	Nom. output W	Nom./peak torque Ncm	Nom./peak current A	Nom. voltage/speed V/rpm	torque Constant Ncm/A	Resistance Ohm/winding	Inductance mH/winding	Rotor inertia gcm²	Weight kg	Length "A" mm
DB42S01	30.0	5 / 15	0.88 / 2.63	48 / 6000	5.70	3.50	5.80	24	0.25	41
DB42S02	40.0	5 / 30	3.57 / 10.78	17 / 8000	1.40	0.20	0.26	24	0.25	41
DB42S03	26.0	6.25 / 19	1.79 / 5.4	24 / 4000	3.50	1.50	2.10	24	0.25	41
DB42M01	70.0	11 / 30	2.12 / 5.77	48 / 6000	5.20	1.30	2.60	48	0.45	61
DB42M02	60.0	7 / 21	1.63 / 4.88	48 / 8500	4.30	0.95	1.80	48	0.45	61
DB42M03	52.5	12.5 / 38	3.47 / 10.6	24 / 4000	3.60	0.80	1.20	48	0.45	61
DB42L01	77.5	18 / 56	5.14 / 15.5	24 / 4000	3.60	0.55	0.80	72	0.65	81
DB42C01	150.0	25 / 75	4.63 / 13.89	48 / 6000	5.40	0.68	1.21	96	0.75	100
DB42C02	140.0	10 / 30	3.57 / 10.71	48 / 14000	2.80	0.16	0.32	96	0.75	100
DB42C03	105.0	25 / 75	6.65 / 20	24 / 4000	3.76	0.30	0.50	96	0.75	100

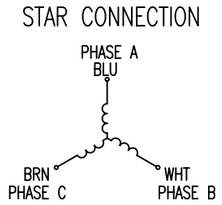
Brushless DC motors - 50 W to 120 W

Option

Gear, Brake, Controller, Encoder

Pin configuration DB57

DB57	Color	Function
Motor	Blue	U
	White	V
	Brown	W
Hall	Orange	+5 V
	Black	GND
	Yellow	H1
	Gray	H2
	Green	H3



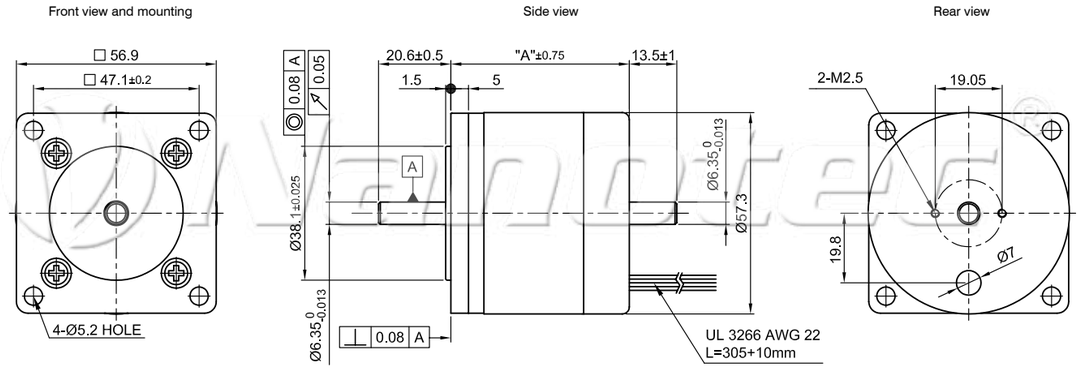
Accessories

Encoder: WEDS...; WEDL...
with 500-1000 pulses.

Brake: Possible on request.

Outline drawing (mm)

DB57 - sizes S, L, C



Available versions (others on request)

Type	Nom. output W	Nom./peak torque Ncm	Nom./peak current A	Nom. voltage/speed V/rpm	torque Constant Ncm/A	Resistance Ohm/winding	Inductance mH/winding	Rotor inertia gcm²	Weight kg	Length "A" mm
DB57S01	50	19 / 56	3.58 / 10.57	24 / 2700	5.30	1.50	1.53	200	0.60	50.8
DB57L01	75	28 / 106	4.67 / 17.67	24 / 2740	6.00	0.80	1.05	330	1.10	76.2
DB57C01	120	37 / 134	5.87 / 21.27	24 / 2800	6.30	0.42	0.62	500	1.50	101.6

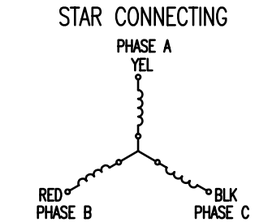
Brushless DC motors - 220 W to 660 W

Option

Gear, Brake, Controller, Encoder

Pin configuration DB87

DB87	Color	Function
Motor	Yellow	U
	Red	V
	Black	W
Hall	Red	+5 V
	Blue	H1
	White	H2
	Green	H3
	Black	GND



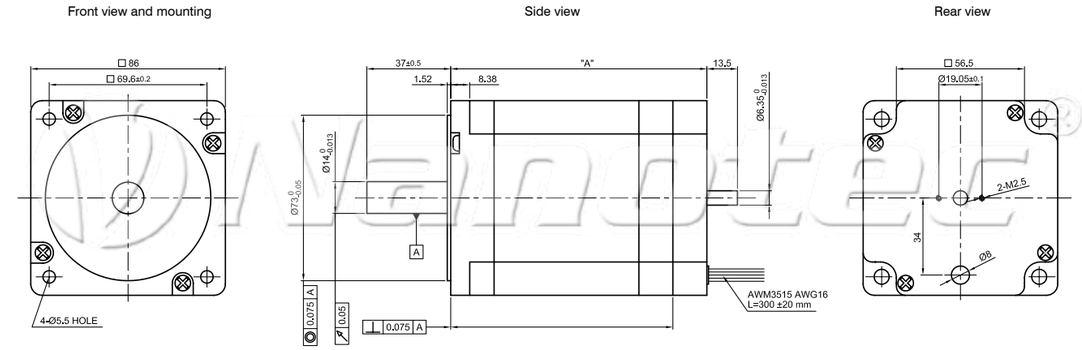
Accessories

Encoder: WEDS...; WEDL...
with 500-1000 pulses

Brake: Possible on request.

Outline drawing (mm)

DB87 - sizes S, M, L



Available versions (others on request)

Type	Nom. output W	Nom./peak torque Ncm	Nom./peak current A	Nom. voltage/speed V/rpm	torque Constant Ncm/A	Resistance Ohm/winding	Inductance mH/winding	Rotor inertia gcm²	Weight kg	Length "A" mm
DB87S01-S	220	70 / 201	6.25 / 17.95	48 / 3000	11.20	0.18	0.35	800	1.85	86
DB87M01-S	440	140 / 420	10.77 / 32.31	48 / 3000	13.00	0.07	0.53	1600	2.60	113
DB87L01-S	660	210 / 630	17.95 / 53.85	48 / 3000	11.70	0.07	0.10	2400	4.00	140

ASB42 brushless DC motor with terminal box

Option

Gear Controller

Pin configuration

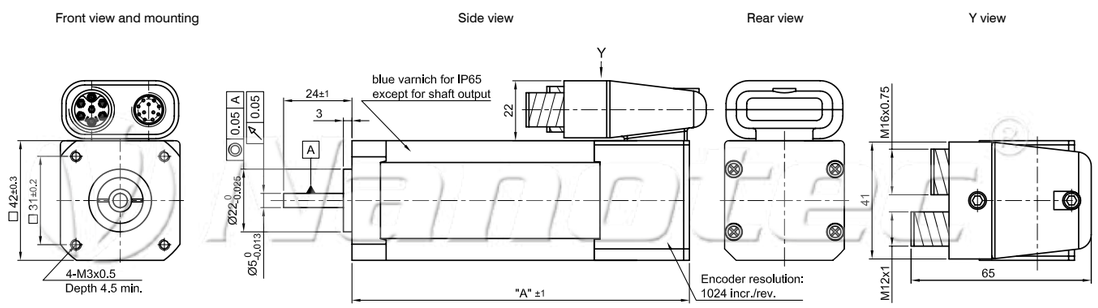
TWINTUS CONNECTOR M12 12 pin	
PIN NO.	ENC./HALL
1	GND
2	5 V
3	GND
4	A
5	A\
6	B
7	B\
8	I
9	I\
10	H1
11	H2
12	H3

TWINTUS CONNECTOR M16 3 pin	
PIN NO.	FUNCTION
1	U
2	V
3	W

Encoder: Integrated magnetic 3-channel encoder with line driver (5 V TTL), 1024 pulses/rev.

Outline drawing (mm)

ASB42 for flange size 42



Available versions (others on request)										
Type	Nom. output W	Nom./peak torque Ncm	Nom./peak current A	Nom. voltage/speed V/rpm	torque Constant Ncm/A	Resistance Ohm/winding	Inductance mH/winding	Rotor inertia gcm²	Weight kg	Length "A" mm
ASB42C048060-ENM	150	25 / 75	4.63 / 13.89	48 / 6000	5.40	0.68	1.21	96	0.75	119

Notes

Linear actuators

General information on linear actuators

What linear drives are available:

1. **Linear actuator**

   A threaded bushing is worked into the motor's hollow shaft. It converts the rotary motion of the motor into linear motion for a spindle. The spindle has to be prevented from rotating in order to achieve linear motion.

2. **Linear actuator with linear slide**

   The linear actuator's spindle is coupled with a linear slide, thereby securing it from being twisted out of position.

3. **Linear actuator drive**

   The thread is attached to the motor shaft. The spindle rotates; a nut on the shaft carries out the linear motion.

Nanotec linear drives

- Are constructed to be simple and flexible
- Offer highly reproducible resolution (< 1 μm) and fast feeding (> 300 mm/sec.) at the same motor dimensions
- Allow consistent construction platforms
- Are designed to be energy-saving
- Are partially self-locking and thus can be operated without a brake
- Are low-friction and low-wear due to the PEEK nuts being used
- Are designed in terms of performance so that they represent an affordable and flexible alternative to hydraulic and pneumatic cylinders.

Selecting a suitable design:

1. Which stroke is necessary?
2. Should an encoder or a brake be connected?
3. Should a freely movable end move the load or is a fixed spindle necessary?
4. Are there limits in the application design?

Selecting the motor output:

In order to find a suitable linear drive, you need information about

1. The load being moved,
2. The movement direction (vertical or horizontal),
3. The required feed speed,
4. The acceleration torque,
5. The required torque,
6. The stroke,
7. The positioning and repeatability
8. The maximum permitted spindle clearance

Estimated service life

The force and delivered performance specified in the data sheets is based on a duty cycle of 10% to 20% and has to be reduced accordingly for higher values.

General information on linear actuators

Performance calculation for selecting linear actuators:

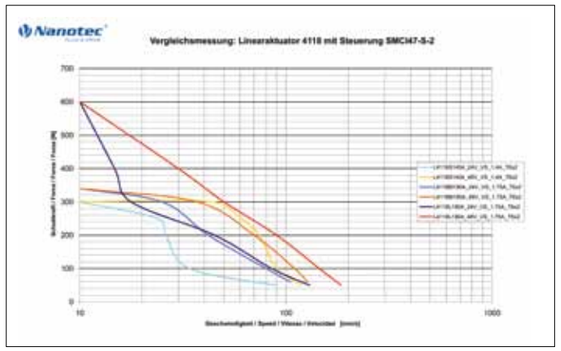
The achievable resolutions, feed speeds and forces are calculated based on the spindle pitch (p in mm), torque (Md in Nm) and efficiency for a stepper motor as follows:

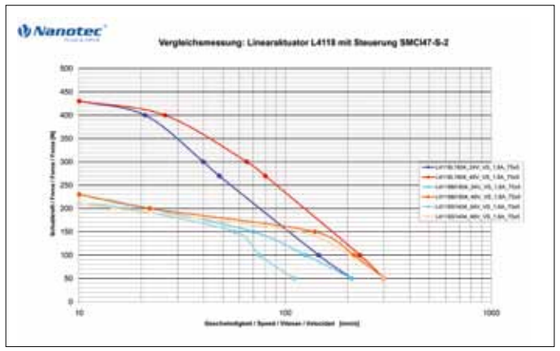
- **Resolution in mm/step**
  Formula: p/(360° / step angle)
  Example: 1 mm / (360° / 0.9°) = 0.0025 mm/step
- **Feed speed**
  Formula: Speed x spindle pitch
  Example: 900 rpm x 2 mm = 30 mm/s
- **Force in N**
  Formula: $Md_{Mot} \times 2\pi \times$ efficiency / p
  Example: Motor L4118S, approx. 0.22 Nm at 48 V, 900 rpm, with a spindle pitch of 2 mm
  F = 0.22 Nm x 6.28 x 0.43/0.002 m = 297 N
- **Efficiency**
  The efficiency of a lead screw drive is approx. 0.3 – 0.6, depending on diameter, pitch, nut material and lubrication.
- **Acceleration torque**
  Formula: Linear: $F = m \bullet a$
  $(a = v_e - v_a / t)$
  v_e = final velocity, v_a = initial velocity
  Formula: Linear: $F = m \bullet g \bullet \mu$
  The **frictional force F** (N) is determined primarily by the mass = **m** (weight, kg) and the coefficient of friction = ***μ***.

The correct thread pitch, motor size and step angle have a substantial influence on the precision, the axial forces and the velocity of the l inear drive.
A curve comparison can enable a specific model to be selected if framework data is known.

Curve comparison for selecting a linear actuator

The curve comparison makes the differences obvious that need to be taken into account during the selection process.
Both graphics show the curves for a performance comparison using the L4118 linear actuator model with T5x5 and T6x2 threading as an example.





! Caution: Ensure that no radial forces are being applied to the spindle and that the spindle is running concentrically relative to the motor shaft. The spindle has to be prevented from rotating in order to achieve linear motion.

Accessories

Suitable spindles are available for each linear actuator under Accessories (p. 142).

Lubrication:

The linear actuator nut should be lubricated regularly e.g. with Nanolube bearing grease CBY-131.

Notes

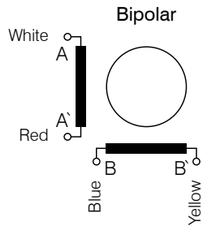
Permanent magnet stepper motor linear actuator LP2515-LP3575

Thanks to the threaded bushing integrated into the motor, rotary motion can be converted to linear motion without elaborate engineering. Thus, this compact design allows space and weight-saving linear adjustment that LP types make available exceptionally affordable in relation to force and speed.

Note: LP type motors are delivered along with a spindle.

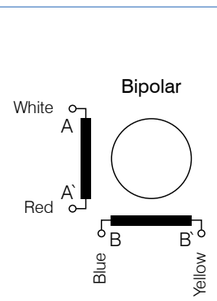
LPV2515S0104

Pin configuration



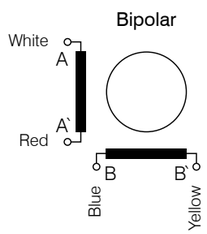
LP2515S0104

Pin configuration



LP3575S0504

Pin configuration

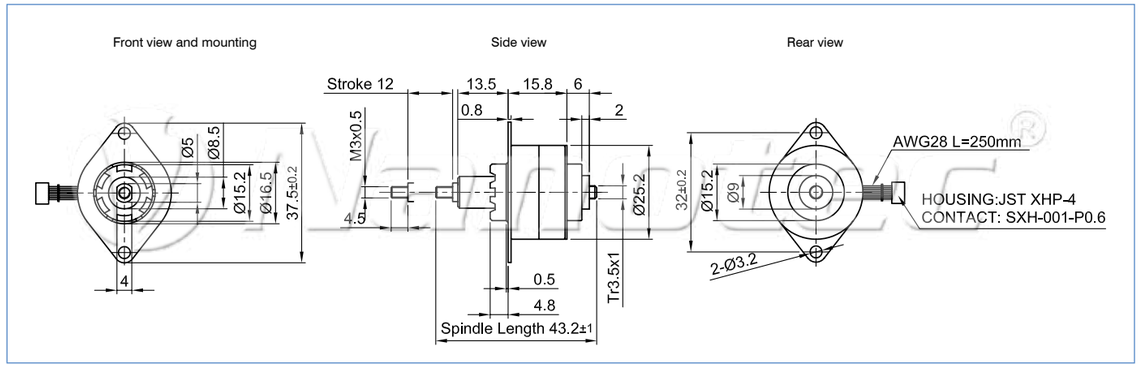


Available versions (others on request)

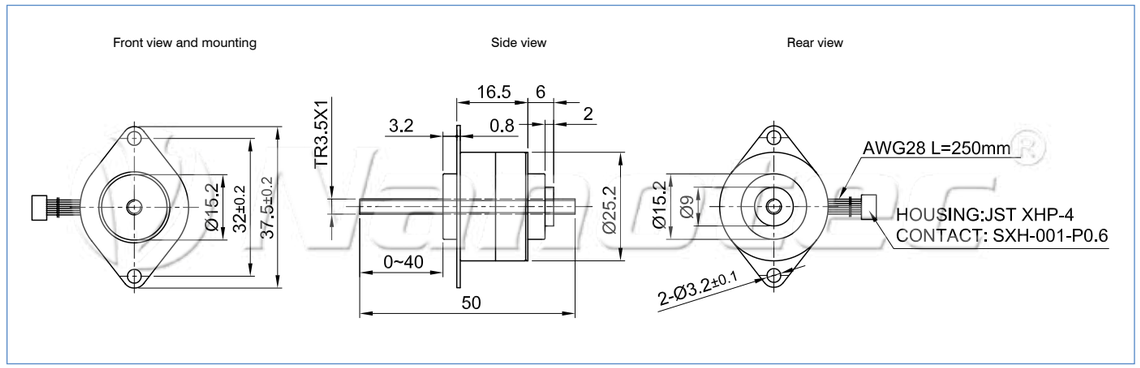
Type	Force	Resolution	Spindle pitch	Travel distance	Current	Resistance per winding	Step angle	Weight	length "A"
	N	mm/step	mm	mm	A/winding	Ohm/winding		kg	mm
	----------Data in full step----------								
LPV2515S0104-TR3.5X1	5	0.0417	1.00	12	0.10	53	15.0	0.036	15.8
LP2515S0104-TR3.5X1	5	0.0417	1.00	40	0.10	53	15.0	0.036	16.5
LP3575S0504-TR3.5X1.22	55	0.0254	1.22	75	0.46	11	7.5	0.086	17.5

All data refer to 1 half of the winding or unipolar!

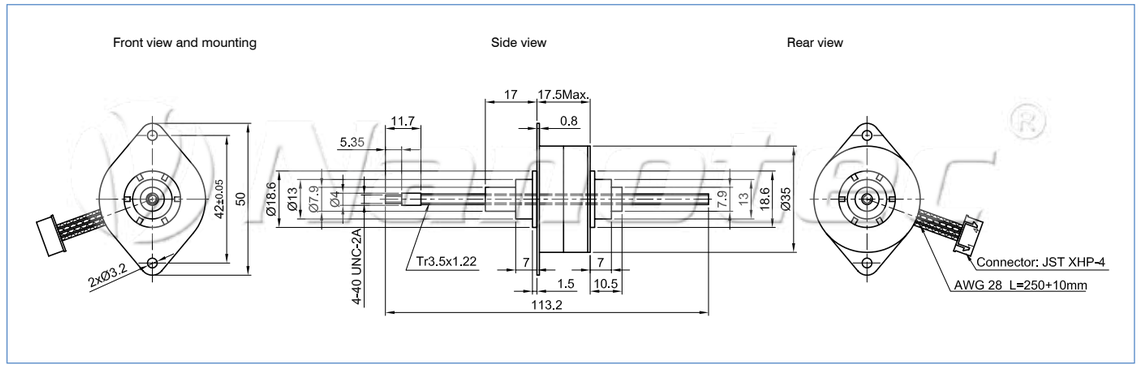
LPV2515S0104 outline drawing (in mm)



LP2515S0104 outline drawing (in mm)



Outline drawing LP3575S0504 (in mm)



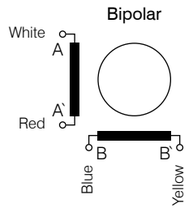
Permanent magnet linear positioning drive types LSP0818 - LSP4275

Option

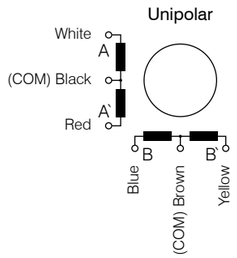
Controller

Pin configuration

LSP08.., 10.., 15..



LSP25.., 35.., 42..



LSP linear positioning drives are based on a permanent magnet stepper motor with a metric thread on the motor shaft so that any rotation of the motor shaft with a matching nut is translated into a linear motion.
The actuators allow finely metered linear adjustments, such as for tracking and positioning sensors and mirrors in medical and optical devices. They are just as suited for engineering tasks that involve tensioning, opening and closing as well as precise tracking of valve and flap adjustments in air conditioning and control devices.

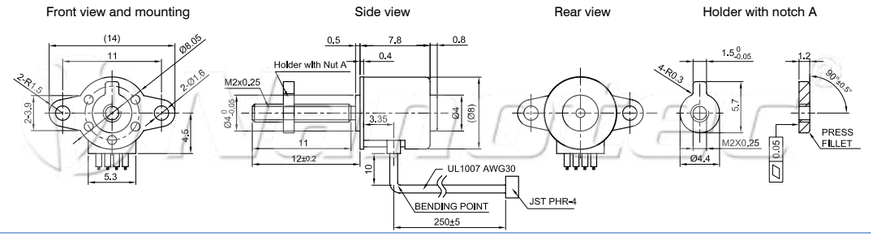
Available versions (others on request)

Type	Force max. F (N)	max. Precision feed control mm/s	Resolution mm/step	Spindle pitch (mm)	Thread Length mm	Current A/winding	Resistance per winding Ohm/winding	Inductance per winding mH/winding	Weight kg	Length "A" mm
	----------Data in full step----------									
LSP0818M0104-M2X0.25	0.8	20	0.014	0.25	11.0	0.12	13	1.5	0.003	7.8
LSP1018M0204-M2X0.25	4.0	20	0.014	0.25	13.5	0.22	15	3.0	0.0043	10.0
LSP1518M0104-M2X0.4	3.0	20	0.020	0.40	18.0	0.07	170	28.0	0.013	11.0
LSP2575M0506-M2X0.4	10.0	15	0.008	0.40	30.0	0.50	10	2.0	0.038	15.0
LSP3575M0206-M3X0.5	40.0	10	0.010	0.50	30.0	0.22	60	45.0	0.094	22.0
LSP4275M0206-M3X0.5	50.0	10	0.010	0.50	30.0	0.18	70	72.0	0.134	22.0

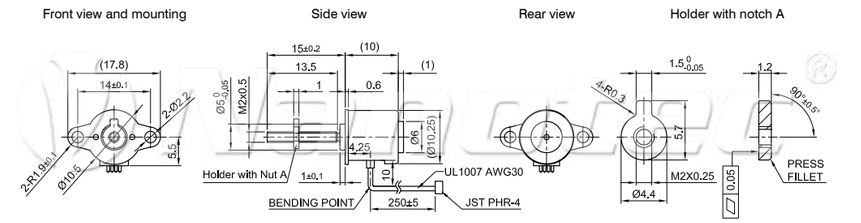
All data refer to 1 half of the winding or unipolar!

Outline drawing (mm)

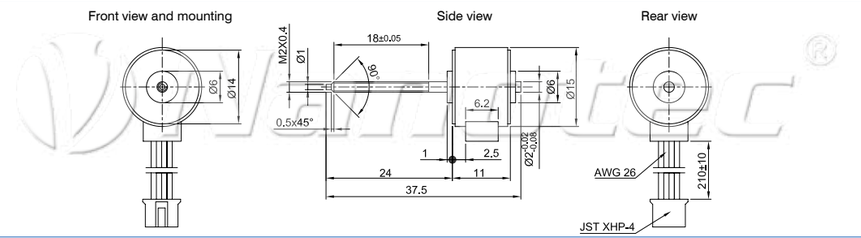
LSP0818M0104



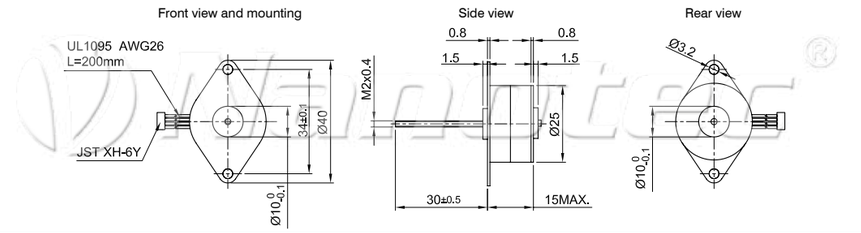
LSP1018M0204



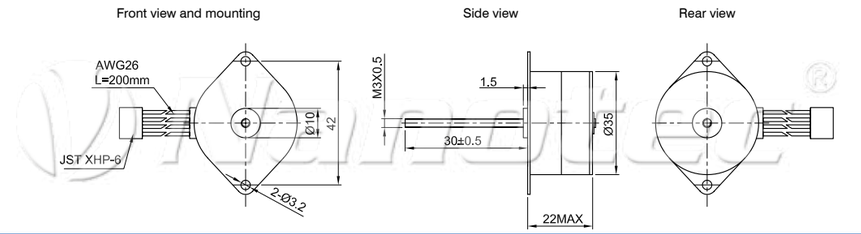
LSP1518M0104



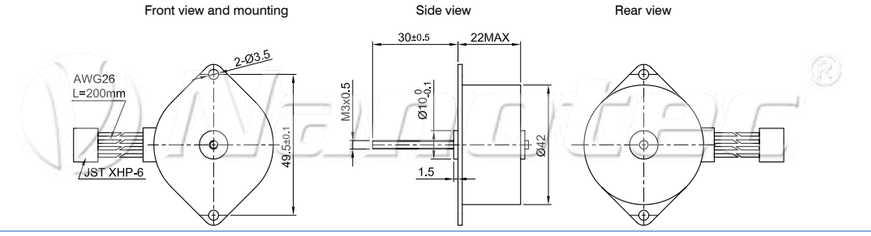
LSP2575M0506



LSP3575M0206



LSP4275M0205

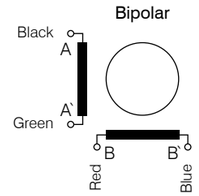


Linear actuator with lead screw (size 20 mm)

Option

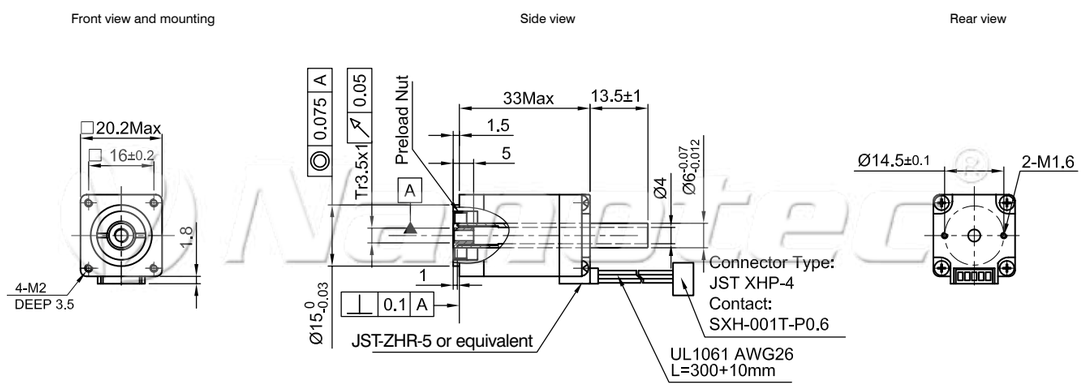
Encoder Controller

Pin configuration



Caution: Suitable threaded spindles and lubricant notes for the integrated PEEK nuts can be found in the Accessories area. (Please order the spindle separately)

L2018... outline drawing (in mm)



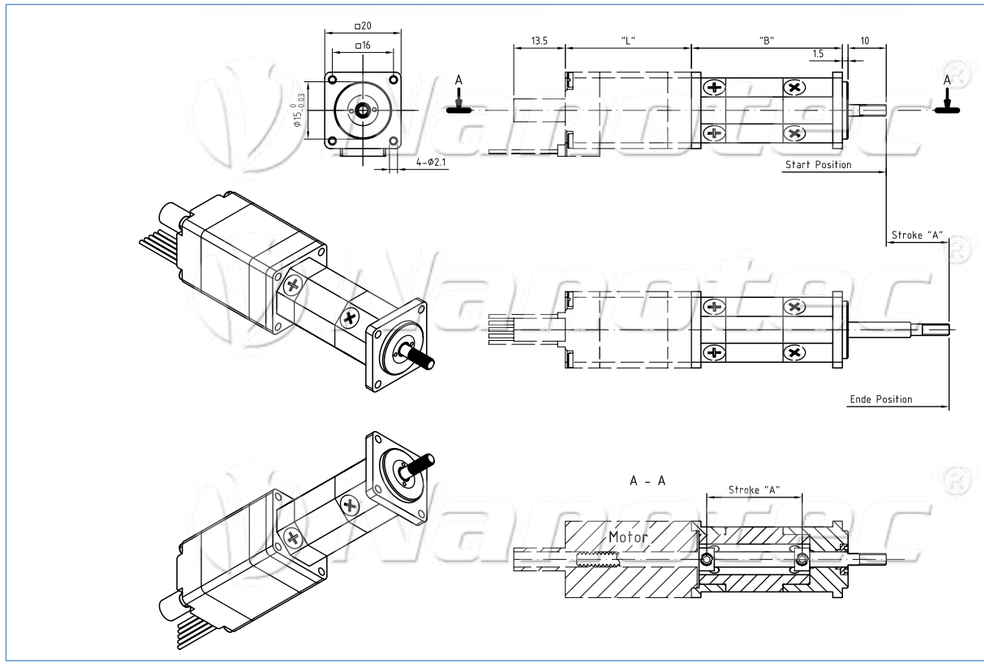
Available versions (others on request)

Type	Force max. F N	Precision feed control max. mm/s at 48 V	Spindle pitch mm	Resolution mm/step	Current/ winding A	Resistance Ohm/windg.	Inductance mH	Weight kg	Bush length 'L' mm	Motor length "A" mm
	----------Data in full step----------									
L2018S0604 -T3.5x1	40	40	1.0	0.005	0.6	6.5	2.0	0.06	20	33

All data refer to 1 half of the winding or unipolar!

Linear actuator with linear slide (size 20 mm)

L2018 with linear guide dimensional drawing (in mm)



Available versions (others on request)

Type	Force max. F N	Precision feed control max. mm/s at 48 V	Spindle pitch mm	Resolution mm/step	Current/ winding A	Resistance Ohm/windg.	Weight kg	Travel length "A" mm	Housing length "B" mm	Motor length "L" mm
	----------Data in full step----------									
L2018S0604 -T3.5x1-25	40	40	1.0	0.005	0.6	6.5	0.09	25	41	33

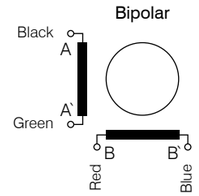
All data refer to 1 half of the winding or unipolar!

Linear actuator with lead screw (size 28 mm)

Option

Encoder Controller

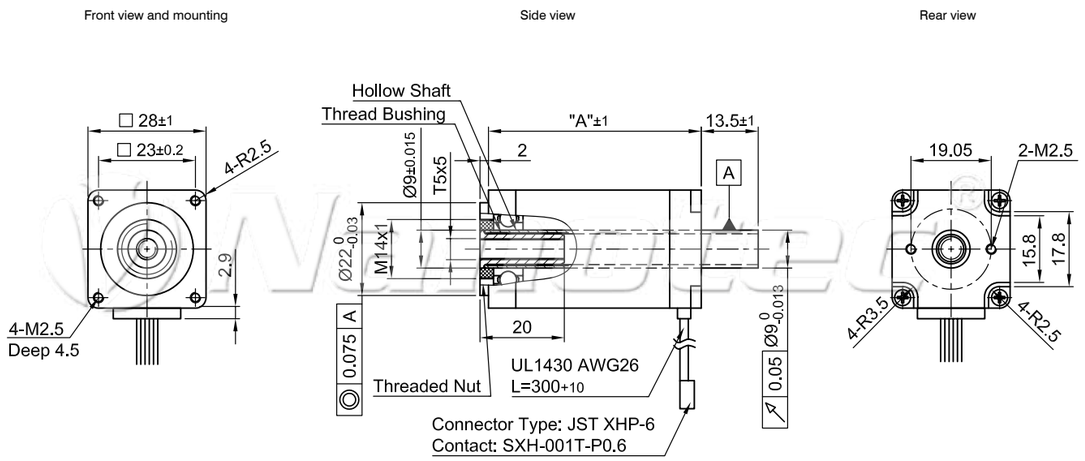
Pin configuration



The combination of a high-torque stepper motor with an economical lead screw with 5 mm pitch provides L28 linear actuators with an exceptionally high adjustment speed of 0.14 m/sec (or extremely short positioning times) as well as still allowing large pushing and pulling forces in its compact form. Even higher operating lifetimes were achieved in addition to simultaneous output improvement due to the relatively high spindle efficiency of > 0.5. Furthermore, resolutions of < 0.01 mm/step are possible using compact microstep drivers and thus linear motors are also exceptionally well-suited for precision linear axes. The linear actuators are also available with an attached encoder (or encoder + line driver) for reporting positions (see Accessories).

! Caution: Suitable threaded spindles and lubricant notes for the integrated PEEK nuts can be found in the Accessories area. (Please order the spindle separately)

L2818... outline drawing (in mm)



Available versions (others on request)

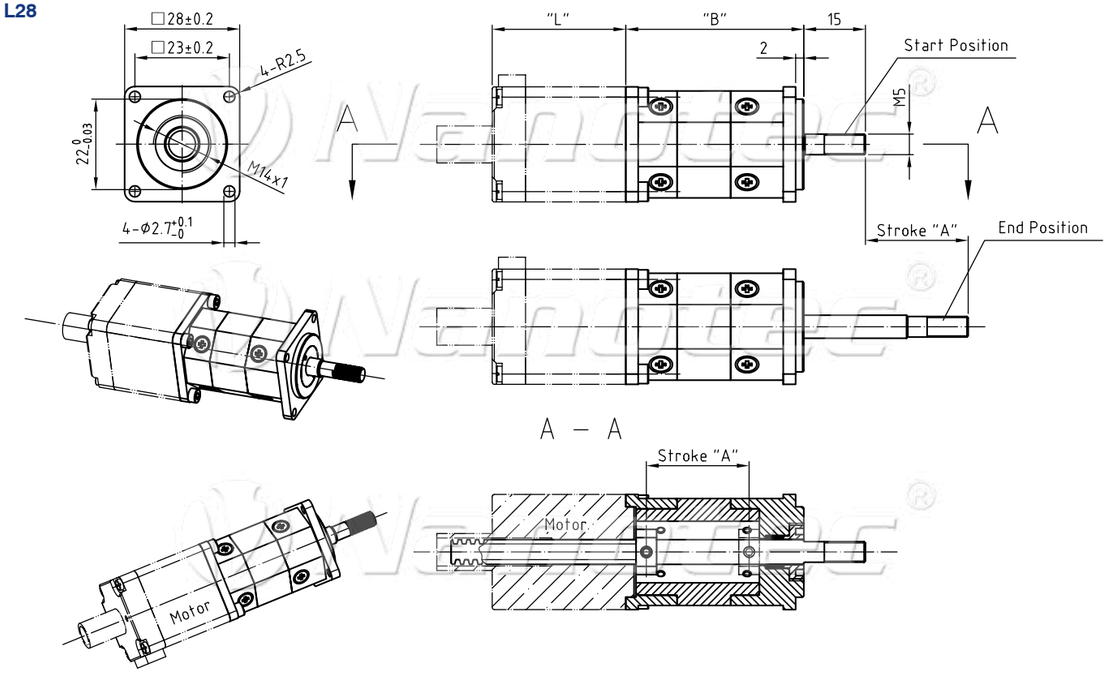
Type	Force max. F N	Precision feed control max. mm/s at 48 V	Spindle pitch mm	Resolution mm/step	Current/ winding A	Resistance Ohm/windg.	Inductance mH	Weight kg	Bush length 'L' mm	Motor length "A" mm
	----------Data in full step----------									
L2818S0604 -T5X5	30	100	5	0.025	0.67	5.60	4.0	0.11	20	31.5
L2818L0604 -T5X5	60	140	5	0.025	0.67	9.20	7.20	0.25	20	50.5

All data refer to 1 half of the winding or unipolar!

Linear actuator with linear slide (size 28 mm)

Outline drawing (mm)

L28



Available versions (others on request)

Type	Force max. F N	Precision feed control max. mm/s at 48 V	Spindle pitch mm	Resolution mm/step	Current/ winding A	Resistance Ohm/windg.	Weight kg	Travel length "A"	Housing length B mm	Motor Length "L" mm
	----------Data in full step----------									
L2818S0604 -T5x5A25	30	100	5	0.025	0.67	5.6	0.26	25	44	31.5
L2818S0604 -A50	30	100	5	0.025	0.67	5.6	0.30	50	69	31.5
L2818L0604 -T5x5A25	60	140	5	0.025	0.67	9.7	0.34	25	44	50.5
L2818L0604 -A50	60	140	5	0.025	0.67	9.7	0.39	50	69	50.5

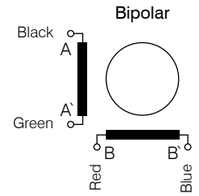
All data refer to 1 half of the winding or unipolar!

Linear actuator with lead screw (size 35 mm)

Option

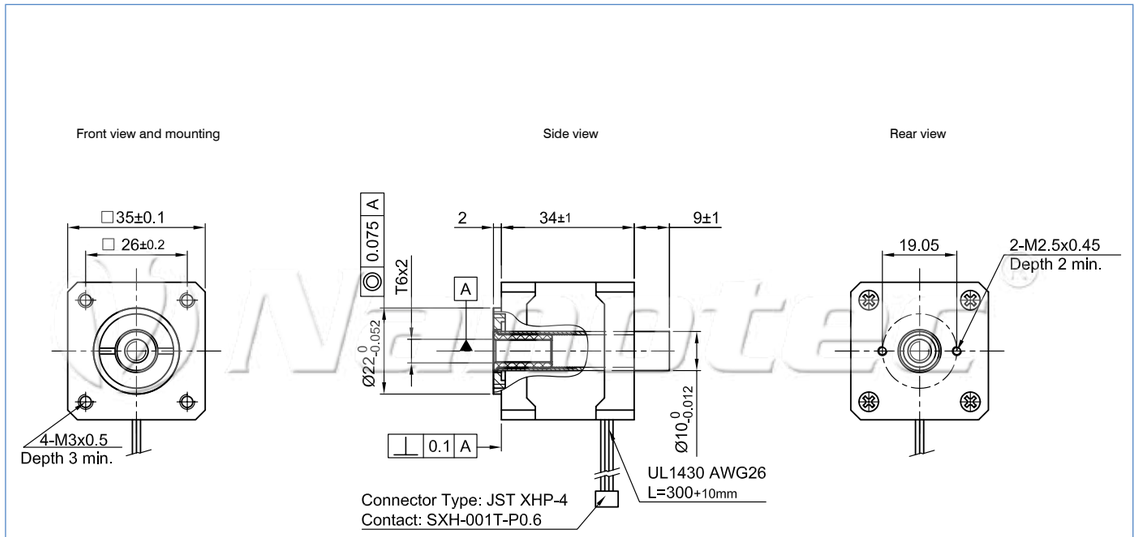
Encoder Controller

Pin configuration



Caution: Suitable threaded spindles and lubricant notes for the integrated PEEK nuts can be found in the Accessories area. (Please order the spindle separately)

L3518S... dimensional drawing (in mm)



Available versions (others on request)

Type	Force max. F N	Precision feed control max. mm/s at 48 V	Spindle pitch mm	Resolution mm/step	Current/ winding A	Resistance Ohm/windg.	Inductance mH	Weight kg	Bush length 'L' mm	Motor length "A" mm
	----------Data in full step----------									
L3518S1204-T6x2	140	100	2	0.01	1.2	1.85	2.0	0.15	20	34

All data refer to 1 half of the winding or unipolar!

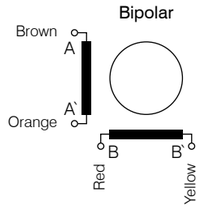
Notes

Linear actuators with fine-pitch thread and lead screw (size 41 mm)

Option

Encoder Controller

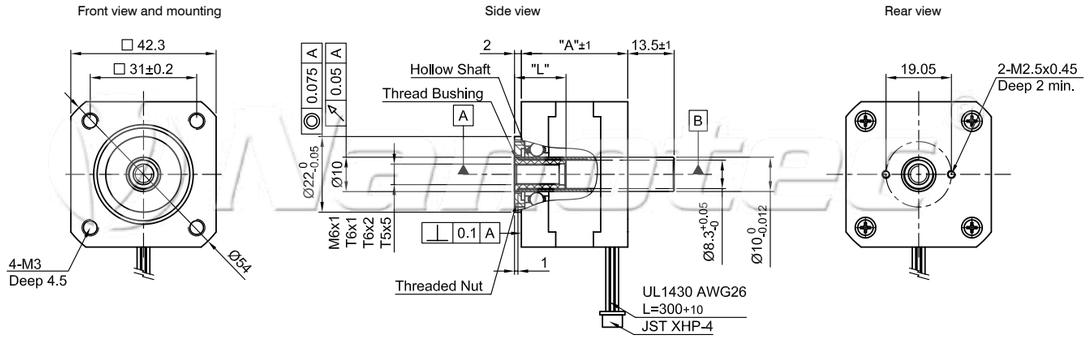
Pin configuration



L41.. precision linear actuators are used for a wide assortment of applications where high resolution capacity is required instead of large positioning forces or speeds with the lowest possible price, construction volume and installation effort. The travel is only limited by the spindle length; as a result exceptionally flexible, path-independent linear movement tasks can be implemented. Resolutions of < 0.005 mm/step are possible for the finest positioning using compact microstep drivers such as SMC types.
Encoders are also optionally available (see Accessories).

! Caution: Suitable threaded spindles and lubricant notes for the integrated bronze nuts can be found under Accessories. (Please order the spindle separately)

L4118.. dimensional drawing (in mm)



Available versions (others on request)

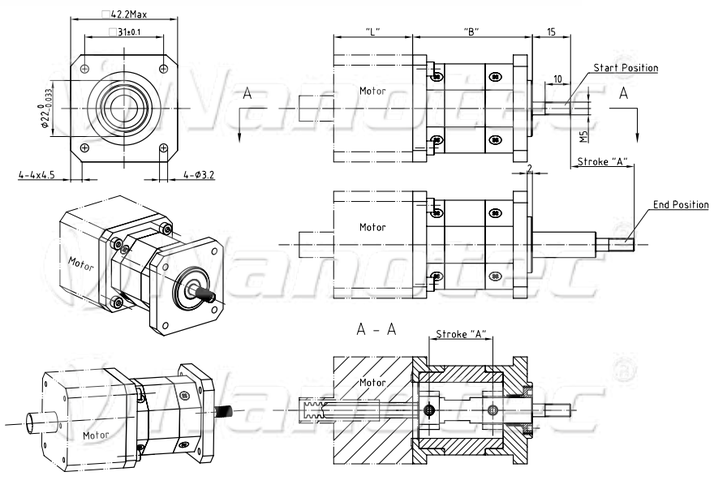
Type	Force max. F N	Precision feed control max. mm/s at 48 V	Spindle pitch mm	Resolution mm/step	Current/ winding A	Resistance Ohm/windg.	Inductance mH	Weight kg	Bush length 'L' mm	Motor length "A" mm
	----------Data in full step----------									
L4118S1404 -M6X1	90	20	1	0.005	1.4	2.00	3.60	0.20	15	31
L4118L1804 -M6X1	200	40	1	0.005	1.8	1.75	3.30	0.34	15	49
L4118S1404 -T6X1	200	50	1	0.005	1.4	2.00	3.60	0.20	15	31
L4118S1404 -T6X2	200	50	2	0.010	1.4	2.00	3.60	0.20	15	31
L4118S1404 -T5X5	100	250	5	0.025	1.4	2.00	3.60	0.20	20	31
L4118M1804 -T6X1	250	50	1	0.005	1.8	1.10	1.85	0.24	15	38
L4118M1804 -T6X2	250	100	2	0.010	1.8	1.10	1.85	0.24	15	38
L4118M1804 -T5X5	150	250	5	0.025	1.8	1.10	1.85	0.24	20	38
L4118L1804 -T6X1	300	80	1	0.005	1.8	1.75	3.20	0.34	15	49
L4118L1804 -T6X2	400	150	2	0.010	1.8	1.75	3.30	0.34	15	49
L4118L1804 -T5X5	250	250	5	0.025	1.8	1.75	3.30	0.34	20	49

All data refer to 1 half of the winding or unipolar!

Linear actuator with linear slide (size 41 mm)

Outline drawing (mm)

L41



Available versions (others on request)

Type	Force max. F N	Precision feed control max. mm/s at 48 V	Spindle pitch mm	Resolution mm/step	Current/ winding A	Resistance Ohm/windg.	Weight kg	Travel length "A"	Housing length "B" mm	Motor Length "L" mm
	----------Data in full step----------									
L4118S1404 -A25	200	20	1	0.005	1.40	2.0	0.35	25	47	31
L4118S1404 -A50	200	20	1	0.005	1.40	2.0	0.40	50	72	31
L4118S1404 -A25	120	40	2	0.010	1.40	2.0	0.35	25	47	31
L4118S1404 -A50	120	40	2	0.010	1.40	2.0	0.40	50	72	31
L4118S1404 -A25	80	100	5	0.025	1.40	2.0	0.35	25	47	31
L4118S1404 -A50	80	100	5	0.025	1.40	2.0	0.40	50	72	31
L4118M1804 -T6x1A25	250	40	1	0.005	1.80	1.10	0.39	25	47	38
L4118M1804 -A50	250	40	1	0.005	1.80	1.10	0.44	50	72	38
L4118M1804 -A25	150	80	2	0.010	1.80	1.10	0.39	25	47	38
L4118M1804 -A50	150	80	2	0.010	1.80	1.10	0.44	50	72	38
L4118M1804 -A25	100	200	5	0.025	1.80	1.10	0.39	25	47	38
L4118M1804 -A50	100	200	5	0.025	1.80	1.10	0.44	50	72	38
L4118L1804 -A25	400	40	1	0.005	1.80	1.75	0.49	25	47	38
L4118L1804 -A50	400	40	1	0.005	1.80	1.75	0.54	50	72	38
L4118L1804 -A25	300	80	2	0.010	1.80	1.75	0.49	25	47	38
L4118L1804 -A50	300	80	2	0.010	1.80	1.75	0.54	50	72	38
L4118L1804 -A25	220	200	5	0.025	1.80	1.75	0.49	25	47	38
L4118L1804 -A50	220	200	5	0.025	1.80	1.75	0.54	50	72	38

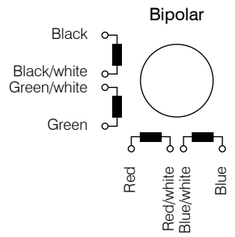
All data refer to 1 half of the winding or unipolar!

Linear actuator with lead screw (size 59 mm)

Option

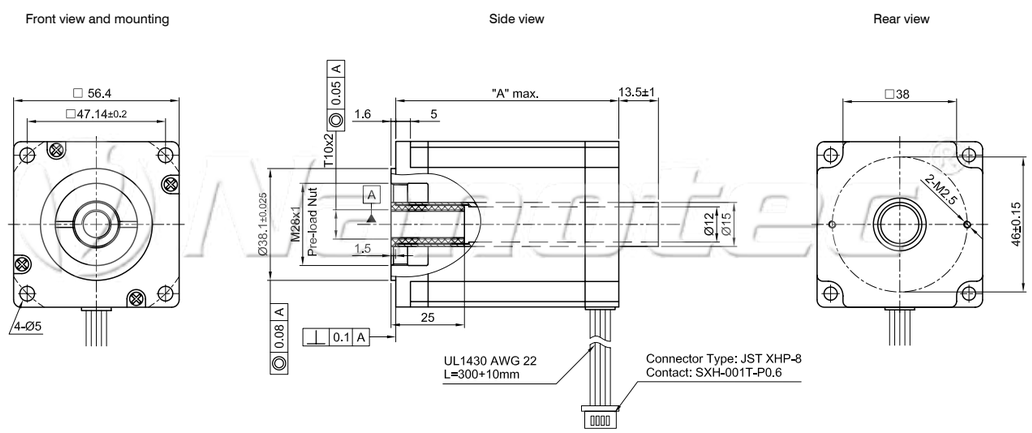
Encoder Controller

Pin configuration



Caution: Suitable threaded spindles and lubricant notes for the integrated PEEK nuts can be found in the Accessories area. (Please order the spindle separately)

L5918S... outline drawing (in mm)



Available versions (others on request)

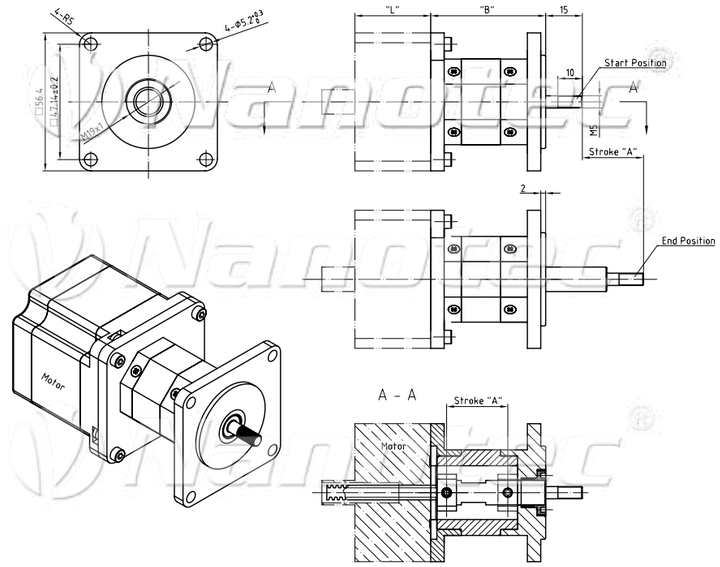
Type	Force max. F N	Precision feed control max. mm/s at 48 V	Spindle pitch mm	Resolution mm/step	Current/ winding A	Resistance Ohm/windg.	Inductance mH	Weight kg	Bush length 'L' mm	Motor length "A" mm
		Data in full step								
L5918S2008 -T10X2	600	50	2	0.010	2.0	1.5	2.6	0.65	25	51
L5918L3008 -T10X2	1000	25	2	0.010	3.0	1.0	2.2	1.00	25	76

All data refer to half of the winding or unipolar.

Linear actuator with linear slide (size 59 mm)

Outline drawing (mm)

L59



Available versions (others on request)

Type	Force max. F N	Precision feed control max. mm/s at 48 V	Spindle pitch mm	Resolution mm/step	Current/ winding A	Resistance Ohm/windg.	Weight kg	Travel length "A"	Housing length B mm	Motor Length "L" mm
L5918S2008 -A25	600	50	2	0.01	2.00	1.5	0.80	25	47	51
L5918S2008 -A50	600	50	2	0.01	2.00	1.5	0.85	50	72	51
L5918L3008 -A25	1000	25	2	0.01	3.00	1.0	1.15	25	47	76
L5918L3008 -A50	1000	25	2	0.01	3.00	1.0	1.20	50	72	76

All data refer to half of the winding or unipolar.

Linear positioning drive LS2818 - LS4118

Option

Controller Encoder

LS.. linear positioning drives do not just significantly reduce costs and space requirements for a linear system, since the coupling and a bearing support point are omitted and installation effort is decreased. They also enhance the system characteristics and increase availability for a complete miniature linear axis. Even the linear guide can be omitted when small loads or load ratings are involved, such as when scanning optical, mechanical or acoustic measurements. In addition, other motor, thread nut and spindle variants (>100 pieces) allow simple, quick and affordable system expansion.

Order identifier

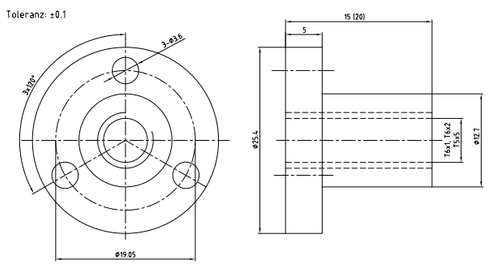
LS4118S1404-T6x2-75

Thread length 75mm

Available thread lengths*:
75 mm and 150 mm

*Only for LS4118

Threaded nut



Order identifier

LSNUT-T6x1-F
LSNUT-T6x2-F
LSNUT-T5x5-F

Material:

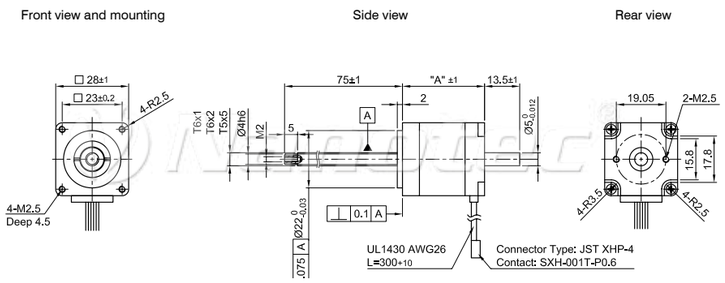
PEEK black for LS2018, LS2818, LS4118

Available versions (others on request)

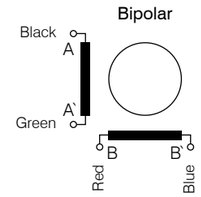
Type	Force (N)	Max. precision feed control mm/s	Resolution mm/step	Current A/winding	Resistance Ohm/winding	Weight kg	Length "A" mm
		Data in full step					
LS2818S0604-T6x1-75	60	20	0.005	0.67	5.6	0.11	32
LS2818S0604-T6x2-75	60	20	0.010	0.67	5.6	0.11	32
LS2818S0604-T5x5-75	30	100	0.025	0.67	5.6	0.11	32
LS2818L0604-T6x1-75	120	30	0.005	0.67	9.2	0.25	51
LS2818L0604-T6x2-75	120	30	0.010	0.67	9.2	0.25	51
LS2818L0604-T5x5-75	60	140	0.0025	0.67	9.2	0.25	51
LS4118S1404-T6x1-XX	200	50	0.005	1.40	2.0	0.20	31
LS4118S1404-T6x2-XX	200	50	0.010	1.40	2.0	0.20	31
LS4118S1404-T5x5-XX	100	250	0.025	1.40	2.0	0.20	31

All data refer to 1 half of the winding or unipolar!

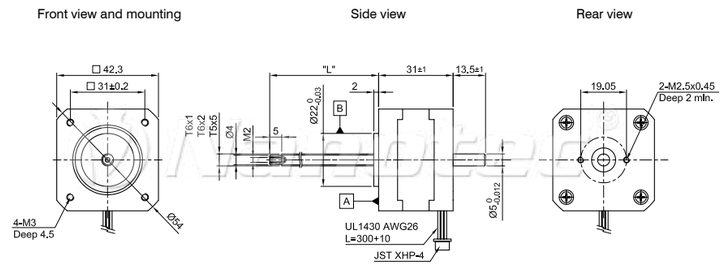
LS2818 outline drawing (in mm)



Pin configuration

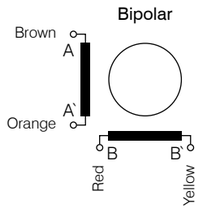


LS4118S1404 outline drawing (in mm)



Thread length "L":
75 mm and 150 mm

Pin configuration



Plug & Drive® Stepper motors

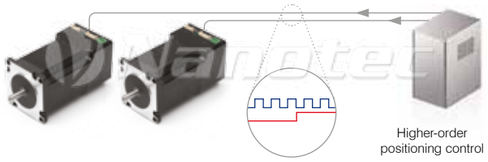
sine commutation

Beyond MicroStepping

field oriented control

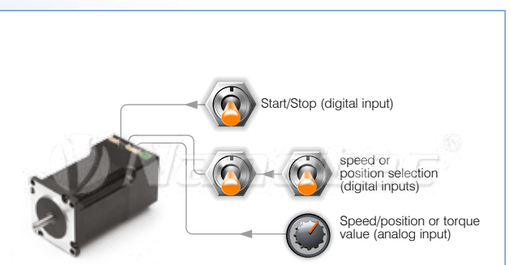
closed loop

Motors with integrated controller



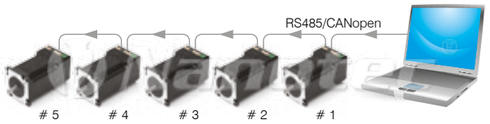
Clock & direction

- Microstep up to a 64th of a step
- Step multiplication/microstep emulation so that the smooth running of the microstep can also be used with older higher-level controllers that only output full or half steps.



Control via digital and analog inputs

- Up to 32 movement sequences (position or speed profiles) can be stored in the controller, selected using digital inputs, started and stopped
- Also speed, position or torque can be controlled via the analog input
- Inputs are freely configurable for additional functions (e.g. reference switch, enable)



Control via field bus

- Open protocol via RS232/RS485 with adjustable Baud rate of 9.6-115 kbit
- Standard protocol in compliance with CANopen/CiA 402 over CAN-Bus

Sequential control with NanoJ

- Java-based programming language, programs run autonomously (without a PC) on the Plug & Play motor
- Access to all controller parameters and inputs/outputs
- Variables, branches, loops, logical and mathematical functions
- Programs can be stored in the controller via RS485/USB

Beyond MicroStepping: Nanotec closed loop technology

Closed loop-capable stepper motors merge the benefits of stepper and servo motor technology. They are smooth-running with less resonance than stepper motors. They offer position feedback and control, short settling and release times and do not exhibit any more step loss. They are an alternative to a stepper motor if energy efficiency, smooth running and load tolerance are required. Compared to servo motors, they have advantages due to high torque at low speeds, short settling times, correct positioning without back swing and a low price for sizes that are often smaller.

What is closed loop?
Sinusoidal commutation via encoder with field-oriented control is referred to as the closed loop process. The rotor position is detected using the encoder's signals and sinusoidal phase currents are generated in the motor windings. Controlling the vector of the magnetic field ensures that the stator magnetic field is vertical relative to the rotor magnetic field and the field strength corresponds exactly to the desired torque. The controlled current level in the windings provides uniform motor force and leads to a particularly quiet-running motor that can be controlled precisely.

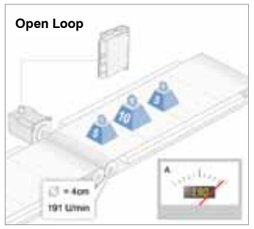
True / Pseudo closed loop
There are stepper motors that dress themselves up as being closed loops and work with encoders but do not provide any field-oriented control with sinusoidally commutated current control. They only check the step position but cannot correct step losses during operation. Real closed loops with field-oriented control compensate for step losses while in motion and can prevent them from happening in the first place by increasing motor current.

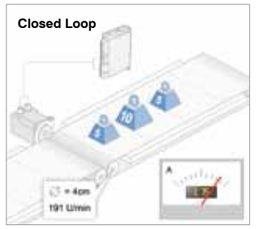
Advantages over standard stepper motors
A stepper motor is used wherever movement to fixed positions is required. The classic stepper motor transfers electric energy into precise mechanical movements as long as the motor's torque is not exceeded. Since there is no position feedback or control present, the motor loses steps if unexpected load jumps or resonance occur and it no longer moves to the desired position. A closed loop stepper motor can readjust in those instances and reach the specified position reliably. Using an open control loop, a standard stepper motor is always operated with the same current regardless of the load and this makes it relatively hot in many applications. By controlling current in a closed loop, the current level can be adapted to the required torque; no unnecessary lost heat is produced and energy consumption drops accordingly.

Advantages over servo-motors
In many cases, closed loop stepper motors from Nanotec represent an alternative to servo drives, such as in winding applications or belt drives. The speed and position, and even the torque, can be controlled with precision. This not only achieves the highest maximum torque, the best efficiency and the best dynamics, it also achieves the lowest torque ripple and excellent running smoothness.

Applications for closed loop systems:
Dosing pumps, filler systems, semi-conductor mounting, wafer production, industrial sewing machines, and more. Textile machines, robotics, test and optical inspection systems, tape and belt drives, general multi-axle applications and applications requiring quiet operation, short transient recovery times or accurate positioning.

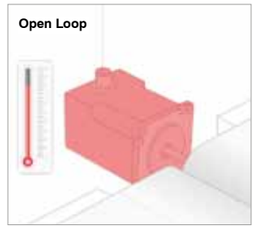
Energy efficiency

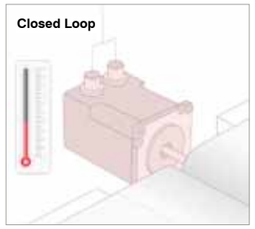




In an open-loop system, the stepper motor is dimensioned such that it is certain to move the maximum required load. For this reason, normally a safety factor of 20% is calculated, which amounts to wasted energy in the application. When the load is reduced, the open-loop motor cannot react and wastes even more energy.

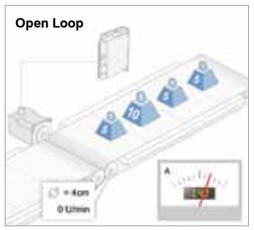
Lifespan

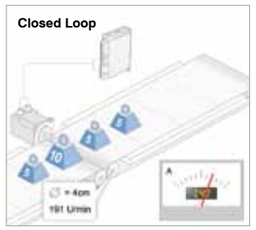




Efficient power regulation generates less heat in the motor, which stays significantly cooler. Reduced heating protects the motor bearings.

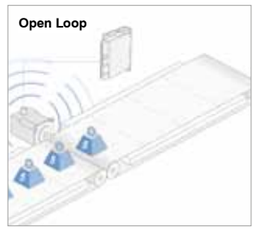
Overload

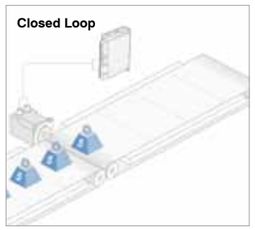




With a 20% safety reserve and a design for a continuous load of 20 kg, an additional load of only 5 kg exceeds the power reserve and the open-loop drive stops without an error message. By contrast, with its overload reserve the closed-loop stepper motor can handle this load increase easily.

Resonances



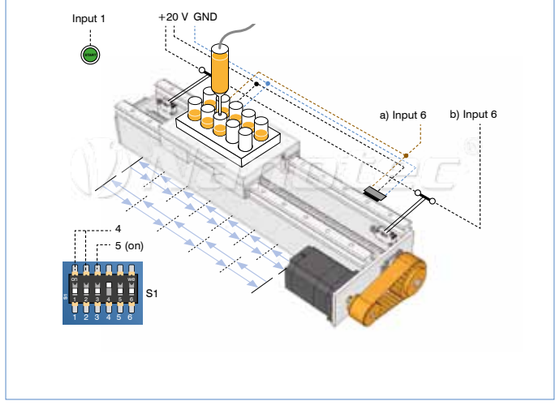


Resonance frequencies occurring in the open loop depend on external loads (the greater the torque reserve, the greater is the resonance stimulation) and can bring the motor to a stop. In closed-loop mode, the motor receives only as much energy as needed for the external load; the torque reserve and its resonance stimulation do not exist, so there is practically no resonance behavior.

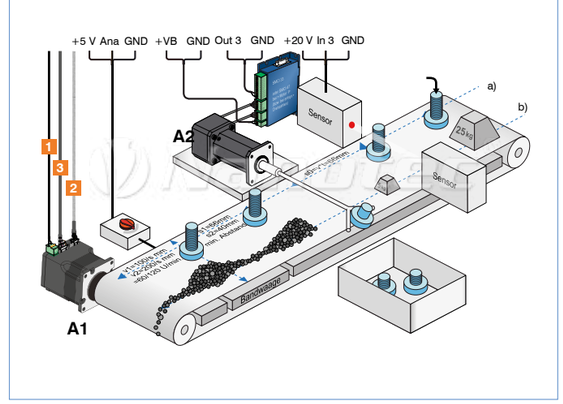
Ideal application areas for closed loop stepper motors:

- Multi-axis applications (series, Ethernet, EtherCAT, CANopen)
- Positioning tasks with load variations
- Winding applications
- Belt drives (start/stop, positioning)
- Dosing pumps, filler systems
- Semi-conductor mounting
- Wafer production
- Textile machines/industrial sewing machines
- Robotics
- Testing and inspection systems
- Applications that require quiet operation, short settling times and precision positioning

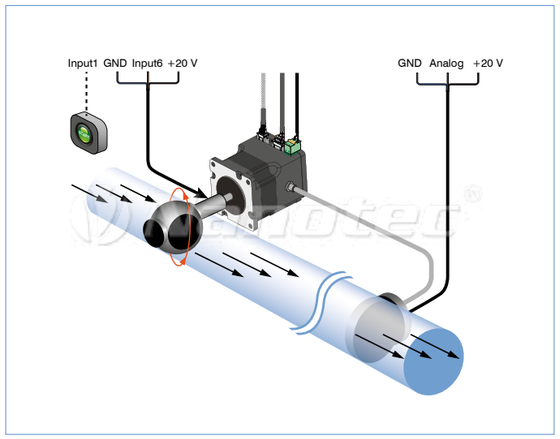
Linear axes (for processing, assembling, etc.)



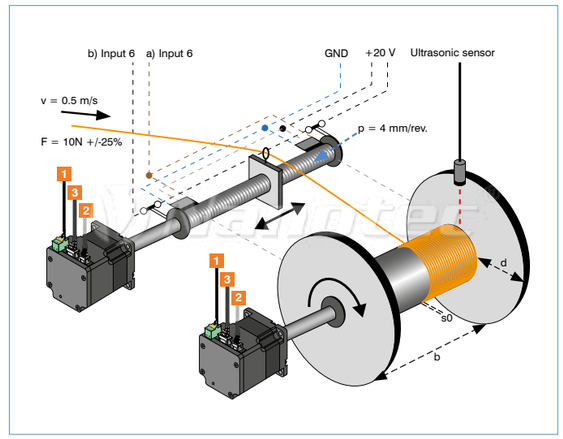
Conveyor belts



Decentralized flow control



Winding and laying

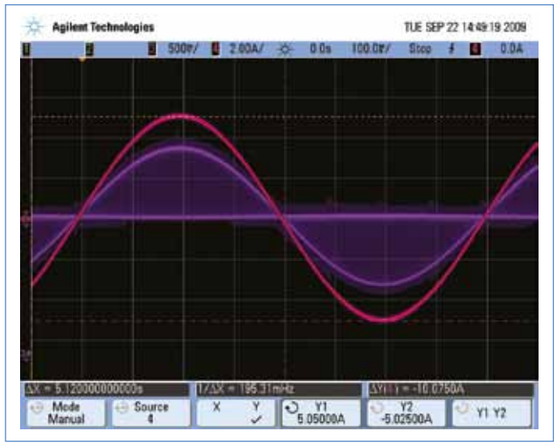


New functions in our intelligent stepper motor controllers and Plug & Drive motors

*dsp***Drive**® – software-based current control with high resolution in the open loop

In the newest generation of Nanotec hardware, the current in the motor is no longer controlled by an integrated component but directly by a digital signal processor instead. Compared to commercially available ICs, which only provide a resolution of 6 or 8 bits for measuring current in the winding and specifying the target current, the entire control process can be carried out using 12-bit resolution with the new dspDrive. The parameters of the PI current controller are adjusted depending on speed.
This has the following application advantages:

- Very quiet, low-resonance operation with sinusoidal current waveform in the windings. Jumps and noise, which encourage the motor towards resonance, no longer occur thanks to the high resolution of the control.



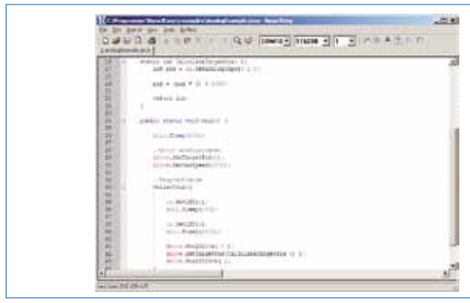
- Even more flexible: Now 3-phase stepper motors and BLDC motors can be controlled by the direct activation of half-bridges using DSP, just like their 2-phase counterparts.

Sinusoidal commutation with encoder in ClosedLoop operation

Instead of just controlling the motor or adjusting the position using an encoder as with conventional stepper motor controllers, the stator magnetic field is controlled like a servo motor using a rotary encoder when using sinusoidal commutation. The stepper motor behaves no different than a multi-pole servo motor in this operating type, i.e. classic stepper motor noises and resonance are gone. The motor is capable of no longer loosing steps up to its maximum torque. The current level is always adjusted to the currently needed torque by the control; as a result, current consumption and heat generation are reduced significantly compared to a classic stepper motor controller if the maximum torque is not used continuously.
Especially with speeds up to 1500 rpm or torques up to 10 Nm, the sinus commutated stepper motor presents an economic alternative to conventional servo systems as, in contrast to these, a direct drive without gears is often possible.

Application programs with NanoJ

Entire sequence programs that are processed autonomously without a higher level controller can be implemented on the controllers using the integrated NanoJ programing language based on the Java standard. Querying and setting digital and analog I/Os and accessing all of the parameters for a movement program turns the stepper motor controller into a full-fledged device controller in conjunction with variables, loops and mathematical functions and everything else that distinguishes a full-fledged higher level language. The programs can be created with the free NanoJEasy editor, compiled directly and written to the controller.

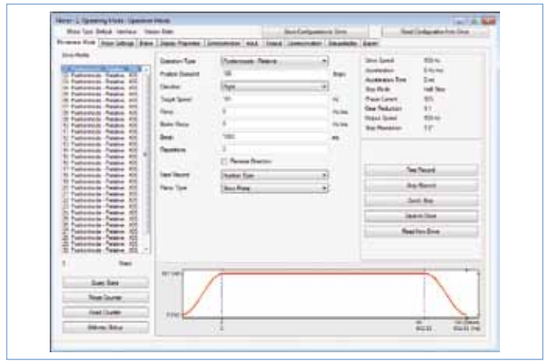


Interpolated mode for CANopen

To date, the Positioning, Velocity and Homing operating modes could be used with our controllers via the CANopen interface in accordance with the DS 402 standard. This is the same for the 6 5-24 V wide-range inputs and the additional output for a holding brake. Using Interpolated Mode, is it now also possible to control Nanotec stepper motor controllers directly via path controllers with a CANopen interface. Thus, for instance, a complete driver is available for the CoDeSys V3 SoftMotion software PLC in order to integrate the controller easily.

Simple commissioning and parameterization with NanoPro and NanoCAN

Via USB or the serial interface (or via a CAN converter from the manufacturers Ixxat or Peak for CANopen), all controls and Plug & Drive motors can be quickly and easily parameterized and tested using the two free software tools NanoPro and NanoCAN (using the example of NanoPro below):

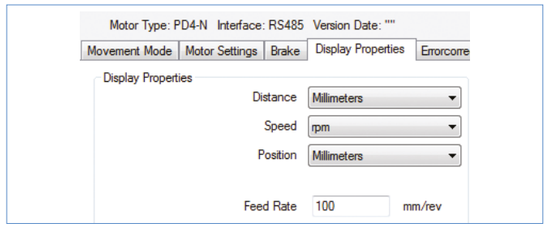


Start preset set 1 (relative positioning) with standard parameters (relative positioning, speed, ramp, etc.) in order to test whether motor is connected properly.

Optimize motor operation for the application, e.g. speed mode with different start/target speeds, ramps and motor currents, open and closed loop.

Select the relevant operation mode for the application (e.g. absolute positioning, speed control via analog input, torque, etc.) and save the parameters to the controller.

The connected controller is identified automatically and default values for various motors can be loaded. All motor-related parameters such as max. current level, current reduction, step mode, etc. are easily configurable here.



Machine settings make the parameters more transparent for the operator, thereby simplifying commissioning. Thus, the travel and speed for a linear axis can be configured in mm and m/s and the user does not have to deal with converting to steps and Hz.

Switching states (pos./neg. signal edge) can be defined for the controller's digital inputs and the debouncing time for contact switches can be tested. The function of the inputs, such as release, reference switch, start, stop and set selection can also be set here. Even the voltage thresholds for the analog input can be configured here just like filtering and a dead zone for preventing jerking at the neutral position for joystick applications.

- A closed loop assistant determines the necessary motor and encoder parameters for the closed loop.
  The load angle values are determined by an automatic calibration run.
- The control can be optimized further by autotuning and the option to adjust PID parameters manually.
- Easily switching between open and closed loop operation to compare operating behavior, performance, positioning times, etc.

PD2-O4118 series stepper motor with integrated controller

Option

Gear

Pin configuration RS485

JST-PHDR-12		JST-PHDR-8	
PIN NO.	FUNCTION	PIN NO.	FUNCTION
1	GND	1	GND
2	Input 1	2	GND
3	Input 2	3	Rx-
4	Input 3	4	Rx+
5	Input 4	5	Tx-
6	Input 5	6	Tx+
7	Input 6	7	GND
8	Analog In	8	UB 12-24 VDC
9	Output 1		
10	Output 2		
11	Output 3		
12	GND		

CAN Open pin configuration

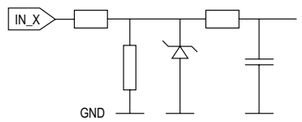
JST-PHDR-12		JST-PHDR-8	
PIN NO.	FUNCTION	PIN NO.	FUNCTION
1	GND	1	GND
2	Input 1	2	GND
3	Input 2	3	n.c.
4	Input 3	4	n.c.
5	Input 4	5	CAN low (CAN-)
6	Input 5	6	CAN high (CAN+)
7	Input 6	7	GND
8	Analog In	8	UB 12-24 VDC
9	Output 1		
10	Output 2		
11	Output 3		
12	GND		

Technical data

Operating voltage:	DC 12 to 24 V
max. phase current:	max. 2.7 A (1% steps) = 150%. 100% = 1.8 A
Interface:	RS485 or CANopen
Operating type:	Cycle direction, position, speed, flag position, analog, joystick. CANopen: Profile positioning, velocity, homing
Step frequency:	Up to 1MHz at 1/64
Inputs:	6 digital inputs (5V TTL), 1 analog input max. +10/min. -10V adjustable
Outputs:	3 open collector, 24V / 0.5 A max.
Current reduction:	Adjustable in values of 1%
Protective circuit:	Overvoltage, undervoltage and temperature > 80°C, integr. ballast switching
Temperature range:	-10 to + 40°C
New functions:	dspDrive / easily programmable as a sequence controller using NanoJ (RS485)

! Caution: An intermediate circuit capacitor of at least 4,700 µF (Z-K4700/50) has to be provided at the supply voltage.

Input circuits



Order identifier

PD2-O4118L1804 ②

2 = RS485
3 = CANopen

Accessories

ZK-SMCI12 incl. RS485
ZK-SMCI12-IO excl. RS485
ZK-SMCI12-3 for CANopen

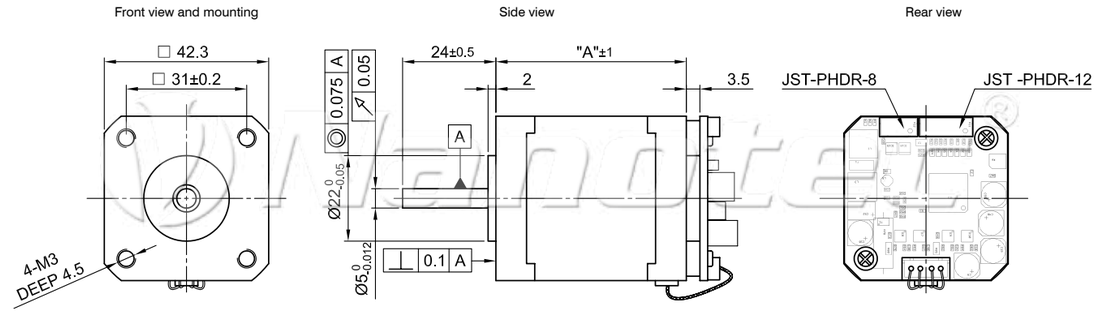
Other cable lengths in large quantities on request.

Available versions (others on request)

Type	Holding torque (duration) Ncm	Weight kg	"A" mm	Interface
PD2-O4118S1404-2	20	0.21	31	RS485
PD2-O4118S1404-3	20	0.21	31	CANopen
PD2-O4118L1804 -2	50	0.39	49	RS485
PD2-O4118L1804 -3	50	0.39	49	CANopen

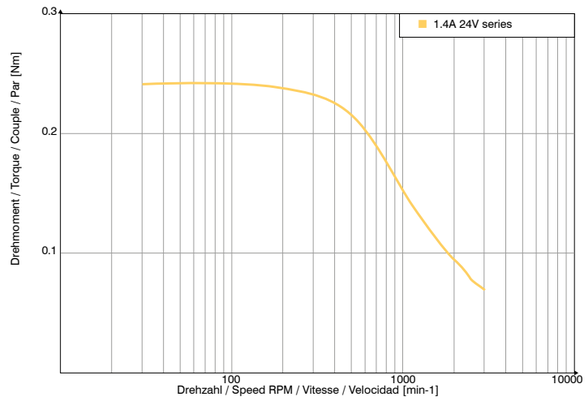
Outline drawing (in mm)

PD2NO4118

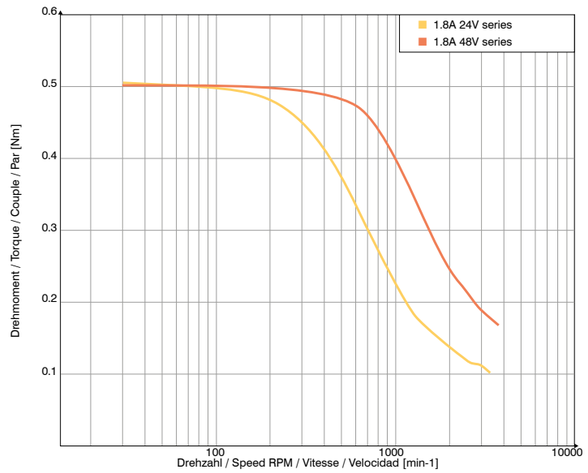


Speed/torque curves

PD2-O4118S1404



PD2-O4118L1804



PD2-N4118 series stepper motor with integrated controller

Option

Gear

Pin configuration RS485

JST-ZPD-10		JST-ZPD-12	
PIN NO.	FUNCTION	PIN NO.	FUNCTION
1	GND	1	GND
2	GND	2	Input 1
3	RS485 Rx-	3	Input 2
4	RS485 Rx+	4	Input 3
5	RS485 Tx-	5	Input 4
6	RS485 Tx+	6	Input 5
7	GND	7	Input 6
8	Vcc	8	Analog input
9	Vcc	9	Output 1
10	GND	10	Output 2
		11	Output 3
		12	GND

CAN Open pin configuration

JST-ZPD-10		JST-ZPD-12	
PIN NO.	FUNCTION	PIN NO.	FUNCTION
1	GND	1	GND
2	GND	2	Input 1
3	RS485 Rx-	3	Input 2
4	RS485 Rx+	4	Input 3
5	RS485 Tx-	5	Input 4
6	RS485 Tx+	6	Input 5
7	GND	7	Input 6
8	Vcc	8	Analog input
9	Vcc	9	Output 1
10	GND	10	Output 2
		11	Output 3
		12	GND

Technical data

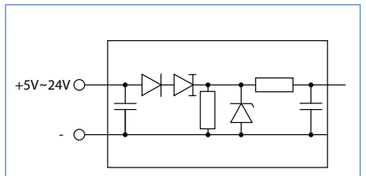
Operating voltage:	12 to 48 V DC
max. phase current:	Adjustable via software up to 2.7 A, (1% increments), 100%=1.8 A
Interface:	RS485 or CANopen
Operating type:	RS485 interface: Position, speed, reference run, flag position, cycle direction, analog and joystick, analog position, torque CANopen interface: Profile position, speed, reference run, interpolated position, torque
Operating mode:	1/1, 1/2, 1/4, 1/5, 1/8, 1/10, 1/16, 1/32, 1/64, adaptive microstep, feed constant
Step angle:	1.8°
Step frequency:	0 to 50 kHz in cycle/direction mode, 0 to 25 kHz in all other modes
Encoder:	Integrated magnetic encoder, 1024 pulses/rev.
Inputs:	6 digital inputs (5-24 V), 1 analog input (+-10V)
Outputs:	3 outputs in open drain circuit (0 switching, max. 24 V / 0.5 A)
Position monitoring:	Automatic error correction up to 0.9°
Current reduction:	Adjustable by values of 1%
Protective circuit:	Overvoltage and heat sink temperature > 80°C
Temperature range:	-10 to + 40°C
Connection type:	Plug connection with JST plugs
New functions:	Closed loop / sinusoidal commutation / dspDrive / programmable as a sequence controller using NanoJ easy (RS485)

Caution: An intermediate circuit capacitor of at least 4,700 µF (Z-K4700/50) has to be provided at the supply voltage.

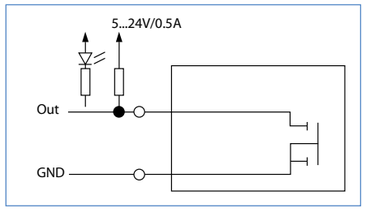
Accessories

ZK-PD2N / ZK-PD2N-3
Connecting cable set 500 mm long with connector

Input circuits



Output circuits



Order identifier

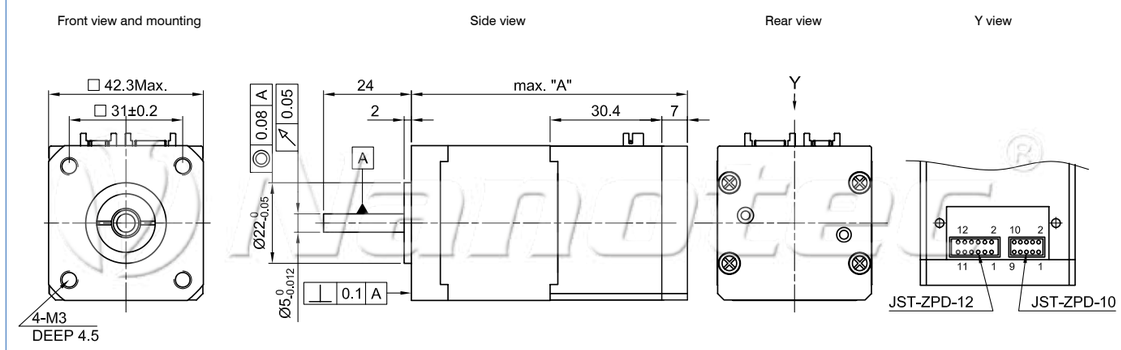
PD2-N4118L1804
2= RS485
3= CANopen

Available versions (others on request)

Type	Holding torque (duration) Ncm	Weight kg	"A" mm
PD2-N4118L1804	50	0.39	76.5

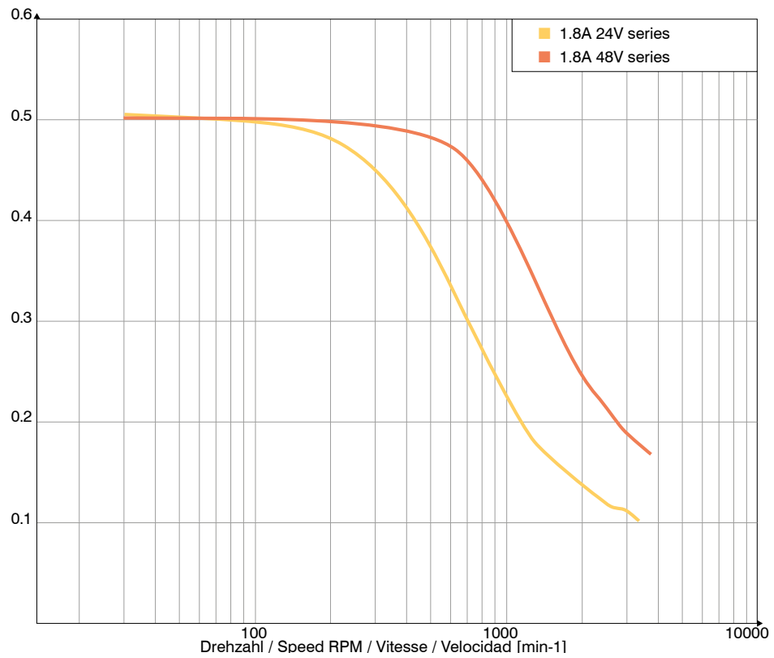
Outline drawing (in mm)

PD2-N4118...



Speed/torque curves

PD2-N4118L1804



PD2-N4118 series stepper motor with integrated controller and terminal box in protection class IP65

Option

Gear

Pin configuration RS485

W12 CONNECTOR 17 PIN		JST-ZPD-12	
PIN NO.	FUNCTION	PIN NO.	FUNCTION
1	Output 1	1	12 - 46 V
2	Output 2	2	12 - 46 V
3	Output 3	3	Power GND
4	Analog input	4	Power GND
5	GND	5	NC
6	GND		
7	RS485 Tx+		
10	RS485 Tx-		
9	RS485 Rx-		
8	RS485 Rx+		
11	Input 1		
12	Input 2		
13	Input 3		
14	Input 4		
15	Input 5		
16	Input 6		
17	NC		

Technical data

Operating voltage:	12 to 48 V DC
max. phase current:	Adjustable via software up to 2.7 A, (1% increments), 100%=1.8 A
Interface:	RS485 or CANopen
Operating type:	Position, speed, flag position, cycle direction, analog, analog position, torque
Operating mode:	1/1, 1/2, 1/4, 1/5, 1/8, 1/10, 1/32, 1/64, adaptive (1/128)
Step frequency:	0 to 50 kHz in cycle/direction mode, 0 to 25 kHz in all other modes
Inputs:	6 digital inputs (5-24 V), 1 analog input (+-10V)
Outputs:	Open drain (0 switching, max. 24 V / 0.5 A)
Position monitoring:	Automatic error correction up to 0.9°
Current reduction:	Adjustable by values of 1%
Protective circuit:	Overvoltage and heat sink temperature > 80 °C
Temperature range:	-10 to + 40 °C
Connection type:	Plug connection with 2xM12
New functions:	Closed loop / sinusoidal commutation / dspDrive / programmable as a sequence controller using NanoJ easy (RS485)

Caution: An intermediate circuit capacitor of at least 4,700 µF (Z-K4700/50) has to be provided at the supply voltage.

CAN Open pin configuration

W12 CONNECTOR 17 PIN		JST-ZPD-12	
PIN NO.	FUNCTION	PIN NO.	FUNCTION
1	Output 1	1	12 - 46 V
2	Output 2	2	12 - 46 V
3	Output 3	3	Power GND
4	Analog input	4	Power GND
5	+VB External	5	NC
6	GND (W001)		
7	CAN - H		
10	CAN - L		
9	GND		
8	GND		
11	Input 1		
12	Input 2		
13	Input 3		
14	Input 4		
15	Input 5		
16	Input 6		
17	GND		

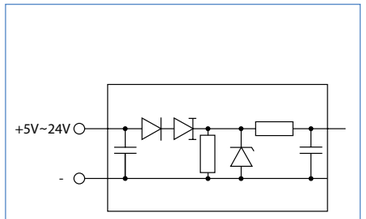
Accessories

ZK-M12-17-1m-2-S-FIN
angled, L=1.5m

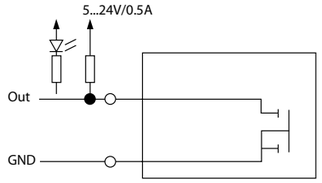
ZK-M12-5-2m-2-pur-S
angled, L=2m

Other cable lengths available for larger quantities upon request

Input circuits



Output circuits



Order identifier

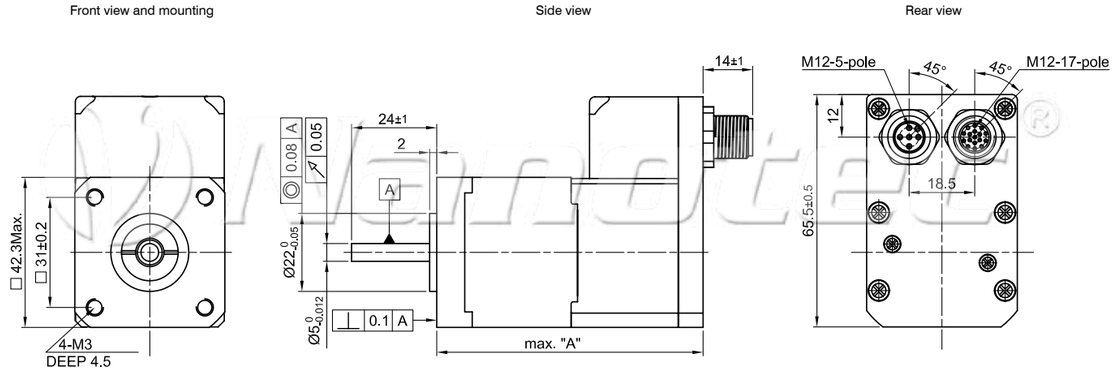
PD2-N4118L1804-IP
2= RS485
3= CANopen

Available versions (others on request)

Type	Holding torque (duration) Ncm	Weight kg	"A" mm
PD2-N4118L1804-IP	50	0.5	76.5

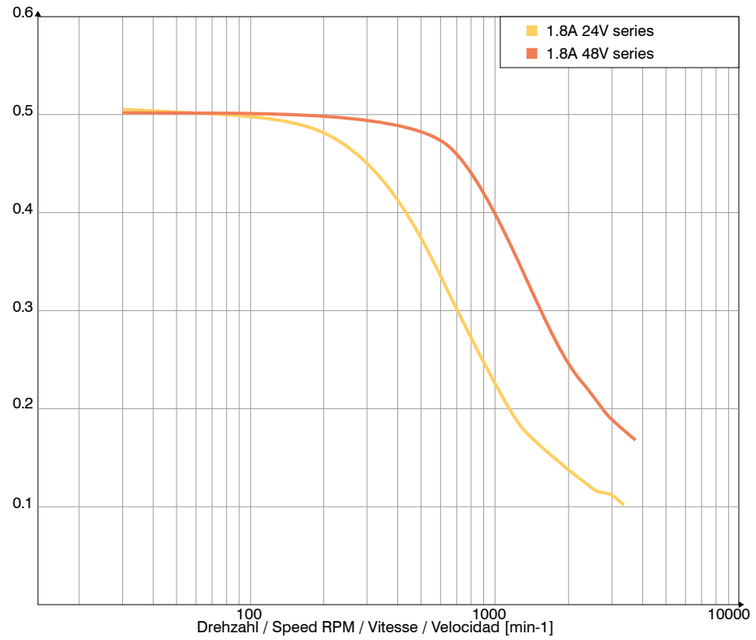
Outline drawing (in mm)

PD2-N4118-IP



Speed/torque curves

PD2-N4118L1804-IP



PD4-N5918/N6018 series stepper motor with integrated controller

Technical data

Operating voltage:	24 to 48 V DC
max. phase current:	Adjustable via software up to 4.8 A, (1% increments), 100%=3.2 A
Interface:	RS485 or CANopen
Operating type:	Position, speed, flag position, cycle direction, analog, analog position, torque
Operating mode:	1/1, 1/2, 1/4, 1/5, 1/8, 1/10, 1/32, 1/64, adaptive (1/128)
Step frequency:	0 to 50 kHz in cycle/direction mode, 0 to 25 kHz in all other modes
Inputs:	6 opto-coupler inputs (5 to 24 V)
Outputs:	Open drain (0 switching, max. 24 V / 0.5 A)
Position monitoring:	Automatic error correction up to 0.9°
Current reduction:	Adjustable by values of 1%
Protective circuit:	Overvoltage and heat sink temperature > 80 °C
Temperature range:	-10 to + 40 °C
Connection type:	Plug connection with JST plugs
New functions:	Closed loop / sinusoidal commutation / dspDrive / programmable as a sequence controller using NanoJ easy (RS485)

Caution: An intermediate circuit capacitor of at least 4,700 µF (Z-K4700/50) has to be provided at the supply voltage.

Option

Gear

Pin configuration

JST PHD-8

PIN	CABLE COLOR	ASSIGNMENT
1	Blue	GND
2	White/pink	+Vb external
3	Yellow	RS485 Rx-
4	Green	RS485 Rx+
5	Pink	RS485 Tx-
6	Gray	RS485 Tx+
7	Brown	CAN+
8	White	CAN-

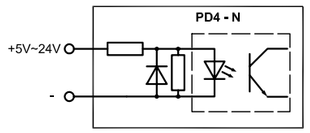
JST PHD-12

PIN	CABLE COLOR	ASSIGNMENT
1	Gray/brown	COM
2	Red	GND
3	Black	Input 1
4	Violet	Input 2
5	Gray/pink	Input 3
6	Red/blue	Input 4
7	White/green	Input 5
8	Brown/green	Input 6
9	White/blue	Analog input
10	White/yellow	Output 1
11	Yellow/brown	Output 2
12	White/gray	Output 3

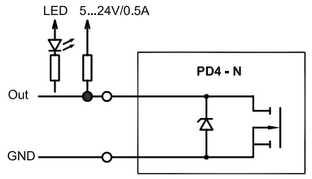
PHÖNIX CONNECTOR FK-MCP 1.5/2-ST-3.5

PIN	CABLE COLOR	ASSIGNMENT
1	Black	GND
2	Brown	UB_IN

Input circuits



Output circuits



Accessories

ZK-PD4N
Connecting cable set
500 mm long with connector

ZIB-PDx-N Interface board for rapid commissioning

ZK-RS485-USB
RS485-USB cable for PC connection

Order identifier

PD4-N5918X4204
PD4-N5918M4204
PD4-N5918L4204

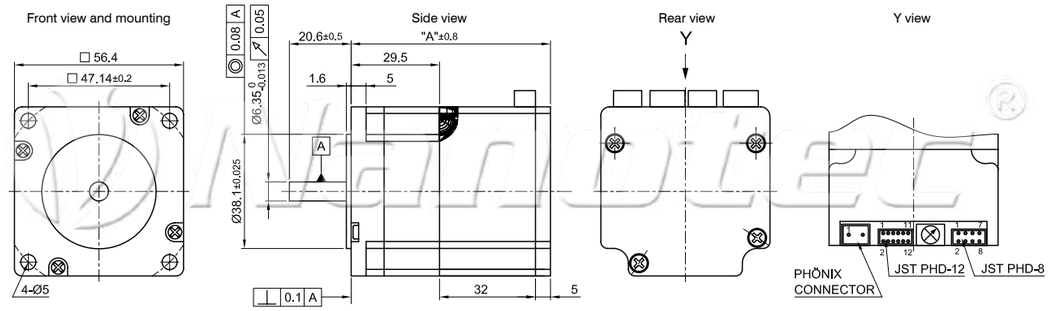
PD4-N6018L4204

Available versions (others on request)

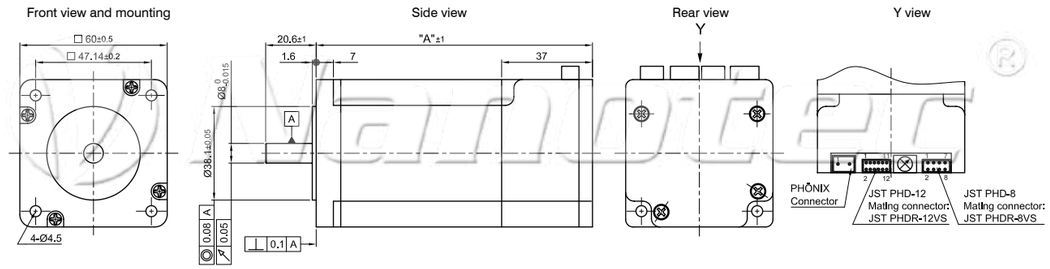
Type	Holding torque Ncm	Weight kg	"A" mm
PD4-N5918X4204	53.7	0.49	66.5
PD4-N5918M4204	113.0	0.80	80.6
PD4-N5918L4204	198.0	1.22	101.6
PD4-N6018L4204	354.0	1.48	112.5

Outline drawing (in mm)

PD4-N5918...

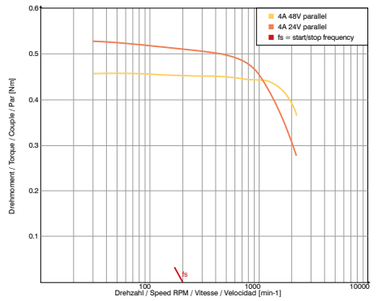


PD4-N6018L4204

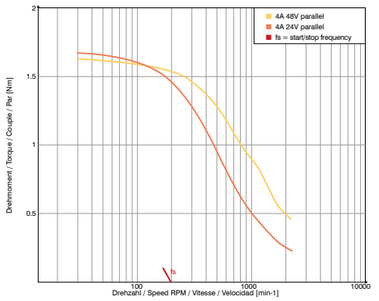


Speed/torque curves

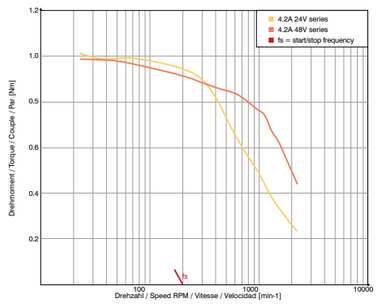
PD4-N5918X4204



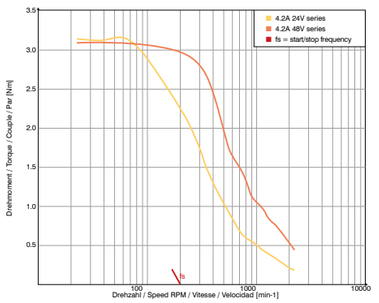
PD4-N5918L4204



PD4-N5918M4204



PD4-N6018L4204



PD4-N5918 series stepper motor with integrated controller and terminal box in protection class IP65

Technical data

Operating voltage:	24 to 48 V DC
max. phase current:	Adjustable via software up to 4.8 A, (1% increments), 100%=3.2 A
Interface:	RS485 or CANopen
Operating type:	Position, speed, flag position, cycle direction, analog, analog position, torque
Operating mode:	1/1, 1/2, 1/4, 1/5, 1/8, 1/10, 1/32, 1/64, adaptive (1/128)
Step frequency:	0 to 50 kHz in cycle/direction mode, 0 to 25 kHz in all other modes
Inputs:	6 opto-coupler inputs (5 to 24 V)
Outputs:	Open drain (0 switching, max. 24 V / 0.5 A)
Position monitoring:	Automatic error correction up to 0.9°
Current reduction:	Adjustable by values of 1%
Protective circuit:	Overvoltage and heat sink temperature > 80 °C
Temperature range:	-10 to + 40 °C
Connection type:	M12
New functions:	Closed loop / sinusoidal commutation / dspDrive / programmable as a sequence controller using NanoJ easy (RS485)

! Caution: An intermediate circuit capacitor of at least 4,700 µF (Z-K4700/50) has to be provided at the supply voltage.

Option

Gear

Pin configuration RS485

M12 CONNECTOR 17 PIN		M12 CONNECTOR 5 PIN	
FUNCTION	PIN NO.	FUNCTION	PIN NO.
Output 1	1	24 - 48 V	1
Output 2	8	24 - 48 V	2
Output 3	3	Power GND	3
Analog input	4	Power GND	4
+VB External	5	N.C.	5
GND	6		
RS485 Tx+	7		
RS485 Tx-	10		
RS485 Rx-	9		
RS485 Rx+	2		
Input 1	11		
Input 2	12		
Input 3	13		
Input 4	14		
Input 5	15		
Input 6	16		
NC	17		

CAN Open pin configuration

M12 CONNECTOR 17 PIN		M12 CONNECTOR 5 PIN	
FUNCTION	PIN NO.	FUNCTION	PIN NO.
Output 1	1	24 - 48 V	1
Output 2	2	24 - 48 V	2
Output 3	3	Power GND	3
Analog input	4	Power GND	4
+VB External	5	N.C.	5
GND	6		
CAN - H	7		
CAN - L	10		
N.C.	9		
N.C.	8		
Input 1	11		
Input 2	12		
Input 3	13		
Input 4	14		
Input 5	15		
Input 6	16		
NC	17		

Order identifier

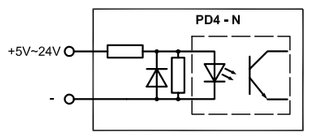
PD4-N5918L4204 - IP - 2

IP = with IP protection

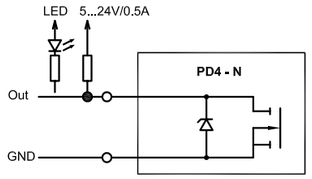
2 = RS485

3 = CANopen

Input circuits



Output circuits



Accessories

ZK-M12-17-1m-2-pur-S, angled, L=1.5m

ZK-M12-5-2m-2-pur-S, angled, L=2m

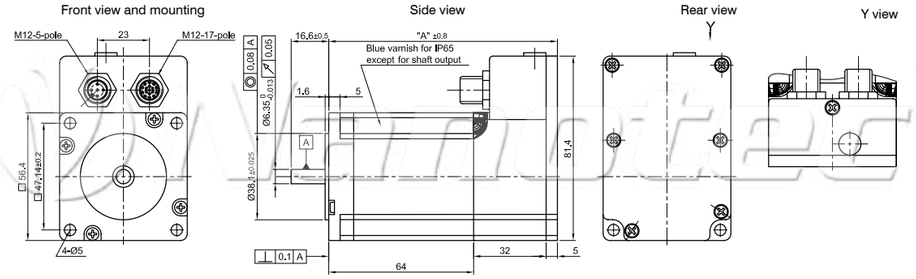
Other cable lengths in large quantities on request.

Available versions (others on request)

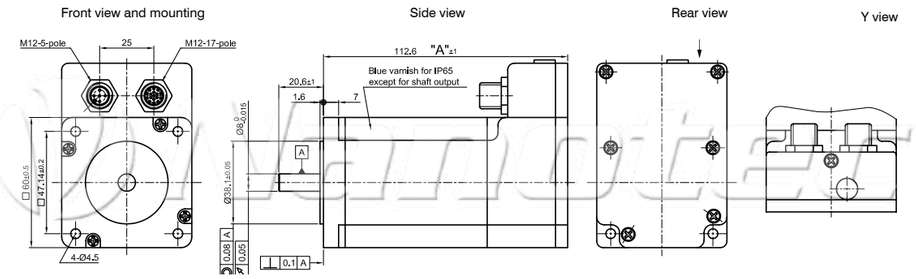
Type	Holding torque Ncm	Weight kg	"A" mm	Interface
PD4-N5918X4204-IP-2	53.7	0.49	66.5	RS485
PD4-N5918X4204-IP-3	53.7	0.49	66.5	CANopen
PD4-N5918M4204-IP-2	113.0	0.80	80.6	RS485
PD4-N5918M4204-IP-3	113.0	0.80	80.6	CANopen
PD4-N5918L4204-IP-2	198.0	1.22	101.6	RS485
PD4-N5918L4204-IP-3	198.0	1.22	101.6	CANopen
PD4-N6018L4204-IP-2	354.0	1.48	112.0	RS485
PD4-N6018L4204-IP-3	354.0	1.48	112.0	CANopen

Outline drawing (in mm)

PD4N5918...-IP

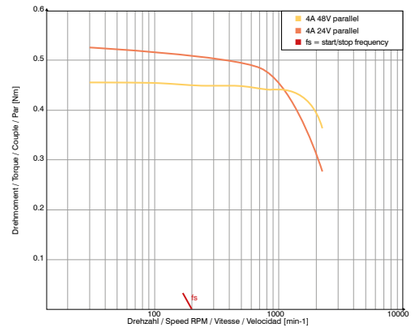


PD4N6018...-IP

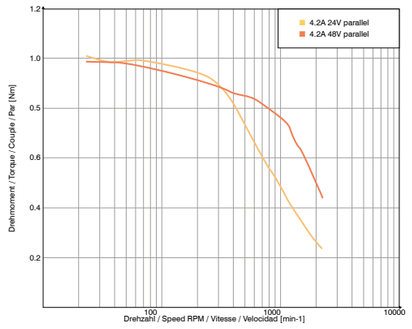


Speed/torque curves

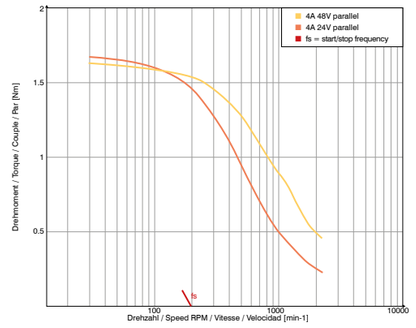
PD4-N5918X4204



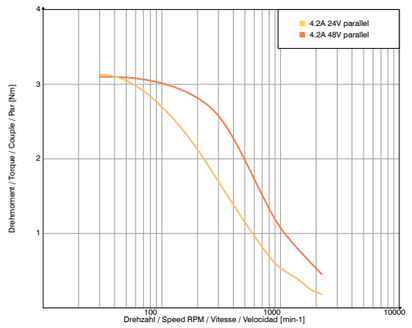
PD4-N5918M4204



PD4-N5918L4204



PD4-N6018L4204



PD6-N8918 series stepper motor with integrated controller

Option

Gear

Technical data

Operating voltage:	24 to 48 V DC
max. phase current:	Adjustable up to max. 10.5 A / phase, 7 A nominal current
Interface:	RS485 or CANopen
Operating type:	Position, speed, flag position, cycle direction, analog, analog position, torque
Position monitoring:	Automatic error correction up to 0.9°
Operating mode:	1/1, 1/2, 1/4, 1/5, 1/8, 1/10, 1/32, 1/64, adaptive (1/128)
Step frequency:	0 to 50 kHz in cycle/direction mode, 0 to 25 kHz in all other modes
Inputs:	6 opto-coupler inputs (5 to 24 V), analog input
Outputs:	Open drain (0 switching, max. 24 V / 1.5 A)
Current reduction:	Adjustable by values of 1%
Protective circuit:	Overvoltage and heat sink temperature > 80 °C
Temperature range:	0 to + 40 °C
Connection type:	2 x 2 m cable
New functions:	Closed loop / sinusoidal commutation programmable as a sequence controller using NanoJ easy (RS485)

Caution: An intermediate circuit capacitor of at least 4,700 μF (Z-K4700/50) has to be provided at the supply voltage.

Pin configuration of cable

SIGNAL CABLE

FUNCTION	COLOR
Input 1	Black
Input 2	Violet
Input 3	Gray/pink
Input 4	Red/blue
Input 5	White/green
Input 6	Brown/green
Analog input	White/blue
Output 1	White/yellow
Output 2	Yellow/brown
Output 3	White/gray

SIGNAL CABLE

FUNCTION	COLOR
RS485 Tx+	Gray
RS485 Tx-	Pink
RS485 Rx-	Yellow
RS485 Rx+	Green
CAN +	Brown
CAN -	White
Signal GND (COM)	Gray/brown
GND	blue + pink/brown
GND LOGIC	Red
+ UB LOGIC	White/pink (20~48V)

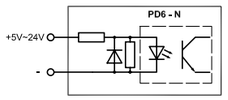
POWER CABLE

FUNCTION	Cable no./COLOR
+ UB	1
GND	2
Protective conductor	Green/yellow

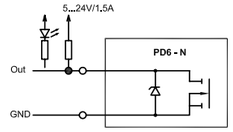
M16 Twintus connector pin configuration

M16 CONNECTOR 18 PIN		M16 CONNECTOR 3 PIN	
FUNCTION	PIN NO.	FUNCTION	PIN NO.
Output 1	1	+ UB	1
Output 2	2	GND	2
Output 3	3	Protective wire	3
Analog input	4		
+VB External	5		
GND	6		
RS485 Tx+	7		
RS485 Tx-	8		
RS485 Rx-	9		
RS485 Rx+	10		
Input 1	11		
Input 2	12		
Input 3	13		
Input 4	14		
Input 5	15		
Input 6	16		
CAN -	17		
CAN +	18		

Input circuits



Output circuits



Accessories

ZIB-PDx-N Interface board for rapid commissioning
ZK-RS485-USB
RS485-USB cable for PC connection
ZK-TW-18 length 2 m
ZK-TW-3 length 2 m
Cable for Twintus connector
Other lengths on request (from 50 units)

Order identifier

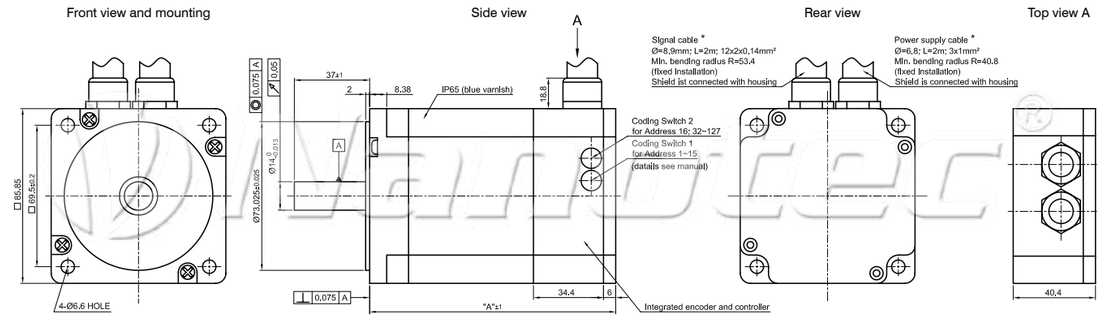
PD6-N8918S6404 -S
S = motor length
S = M16 Twintus connector

Available versions (others on request)

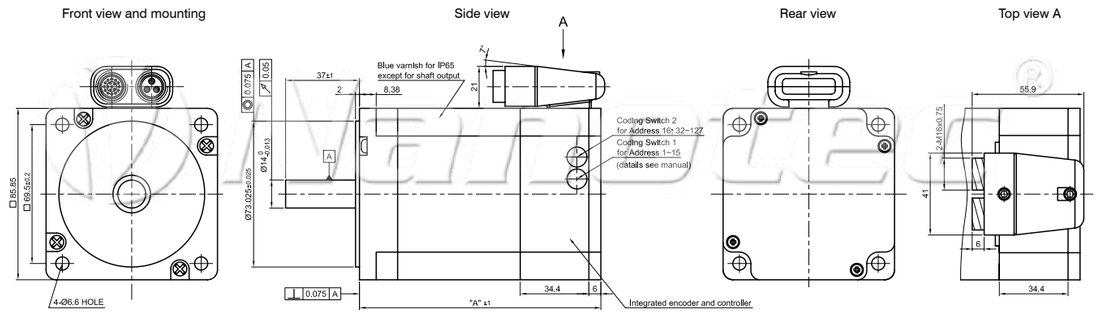
Type	Holding torque Ncm	Supply voltage Ncm	Weight kg	"A" mm	Option with Twintus connector
PD6-N8918S6404	320	24-48	1.7	89	
PD6-N8918S6404-S	320	24-48	1.7	89	X
PD6-N8918M9504	590	24-48	3.4	121	
PD6-N8918M9504-S	590	24-48	3.4	121	X
PD6-N8918L9504	930	24-48	4.0	151	
PD6-N8918L9504-S	930	24-48	4.0	151	X

Outline drawing (in mm)

PD6-N8918...

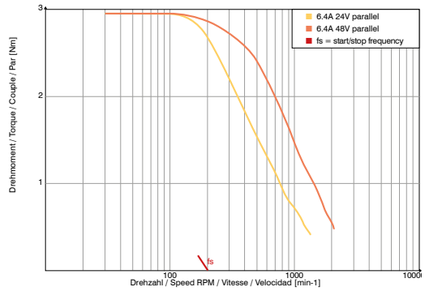


PD6-N8918...-S

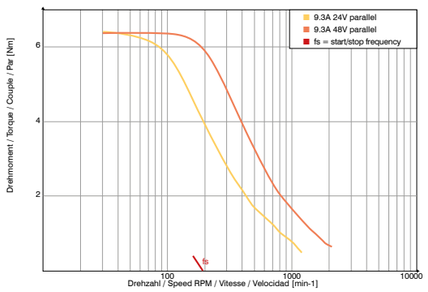


Speed/torque curves

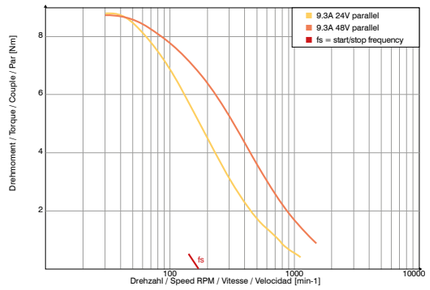
PD6-N8918S6404



PD6-N8918M9504



PD6-N8918L9504



Notes

Motor controls/controllers for Stepper motors and BLDC motors

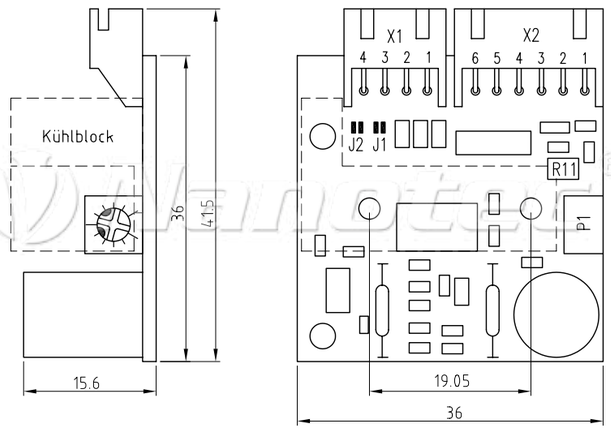
Compact microstep controller SMC11

Technical data

Operating voltage:	12 to 35 V DC
max. phase current:	1.0 A / full step (1.25 A with cooling block) 1.4 A/microstep (1.8 A with cooling block)
Current setting:	Via potentiometer
Operating type:	Bipolar
Operating mode:	1/1, 1/2, 1/4, 1/8 (preset)
Protection function:	Overvoltage, undervoltage and over-temperature
Step frequency:	0 to 200 kHz
Current reduction:	Switchable to 40%
Input signals:	0 V active (L< 0.8 V; 3.5 V < H < 6 V or open)
Temperature range:	0 to + 40 °C
Connection type:	JST plug connector
Weight:	10 g
Fastening type:	2 bore holes at Ø19.05 mm for M2.5 - installed directly on the stepper motor

! Caution: Always use a back-up capacitor for the operating voltage of the control system. This is to be placed as close as possible to the control system. Control systems up to 4 A require a 4700µF capacitor, and control systems up to 10 A require a 10,000µF capacitor. Otherwise, there is a danger of destruction of the control system.

Outline drawing (mm)



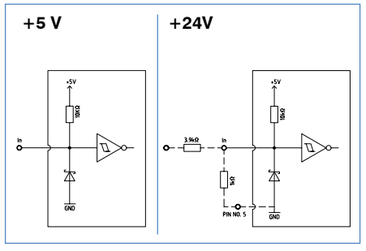
Input configuration, X1:

1=	Phase A
2=	Phase A\
3=	Phase B
4=	Phase B\

Input configuration, X2:

1=	Operating voltage, VSS
2=	Enable (L=active, H or open = disable)
3=	Direction
4=	Clock
5=	Operating voltage (0 V GND)
6=	Current drop

Input circuits



Order identifier

SMC 11 - 2

2 = 1/16 step automatic current reduction

Step switching

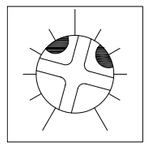
Configuration:
The module is configured to 1/8 step in the factory.

Step mode	J1	J2
1/1 step	X	X
1/2 step	X	
1/4 step		X
1/8 or 1/16 step		

Current setting

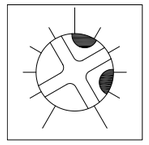
Max. phase current: (microstep)

P1



1.4 A
(without cooling block)

P1



1.8 A
(with cooling block only)

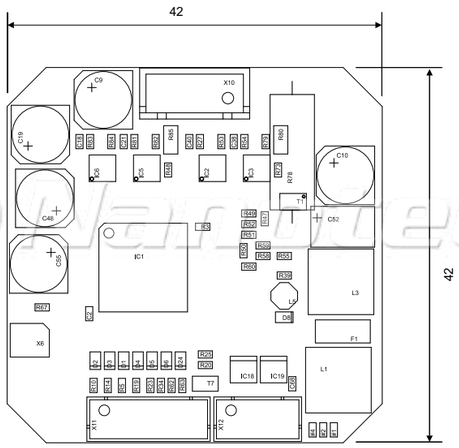
Motor controller SMCI12

Technical data

Operating voltage:	12 to 24 V DC
Phase current:	Nominal current 1.8 A, can be set up to 2.7 A
Interface:	RS485 4-wire or CANopen
Operating type:	RS485: Position, speed, flag position, cycle direction, analog, joystick CANopen: Position, homing mode, velocity mode, interpolated position mode (in compliance with CAN standard DS402)
Operating mode:	1/1, 1/2, 1/4, 1/5, 1/8, 1/10, 1/32, 1/64, adaptive (1/128)
Step frequency:	16 kHz in full step; in microstep, corresponding multiples (e.g. up to 1 MHz at 1/64)
Inputs:	6 digital inputs (TTL), 1 analog input +10 / –10 V
Outputs:	3 open collectors, 24 V / 0.5 A max.
Current reduction:	can be adjusted from 0 to 100%
Protective circuit:	Overvoltage, undervoltage and temperature > 80 °C
Temperature range:	0 to + 40 °C

! Caution: Always use a back-up capacitor for the operating voltage of the control system. This is to be placed as close as possible to the control system. Control systems up to 4 A require a 4700µF capacitor, and control systems up to 10 A require a 10,000µF capacitor. Otherwise, there is a danger of destruction of the control system.

Outline drawing (mm)



Inputs/outputs (X11)

Pin	Function*
1	GND
2	Input 1
3	Input 2
4	Input 3
5	Input 4
6	Input 5
7	Input 6
8	Analog In
9	Output 1
10	Output 2
11	Output 3
12	GND

Supply and communication (X12)

Pin	Function*	
	RS485	CANopen
1	GND	GND
2	GND	GND
3	RX-	n.c.
4	RX+	n.c.
5	TX-	CAN low (CAN-)
6	TX+	CAN high (CAN+)
7	GND	GND
8	UB 12-24 VDC	UB 12-24 VDC

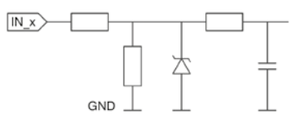
Motor connection (X3)

Pin	Function*
1	Motor coil A
2	Motor coil A\
3	Motor coil B
4	Motor coil B\

*** from the perspective of the connected controller**

Connection cable for motors with 6 or 8 connectors: ZK-XHP-4-300

Input circuits



Order identifier

RS-485: SMCI12

CANopen: SMCI12 - 3

Closed loop motor controller with encoder input, SMCP33

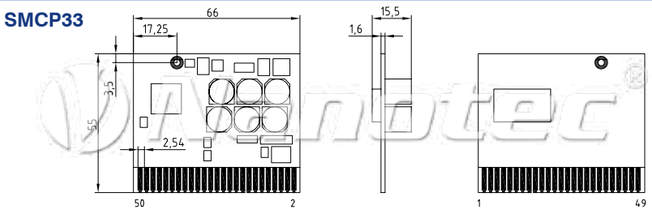
Technical data

Operating voltage:	12 to 48 V DC
Phase current:	Nominal value 2 A (effective), with heat sink 4 A
Interface:	RS485, USB
Operating type:	Position, speed, flag position, cycle direction, analog, joystick, torque
Operating mode:	1/1, 1/2, 1/4, 1/5, 1/8, 1/10, 1/32, 1/64, adaptive (1/128)
Step frequency:	0 to 50kHz in cycle/direction mode, 0 to 25 kHz in all other modes
Inputs:	8 inputs (5 V), 2 analog inputs (-10 to +10 V)
Outputs:	8 outputs (5 V, max. 20 mA TTL)
Position monitoring:	Automatic error correction up to 0.9°, only with optical encoder (e.g. series WEDS5541)
Current reduction:	can be set 0 to 100%
Protective circuit:	Overvoltage, undervoltage and temperature > 80 °C
Temperature range:	0 to + 40 °C

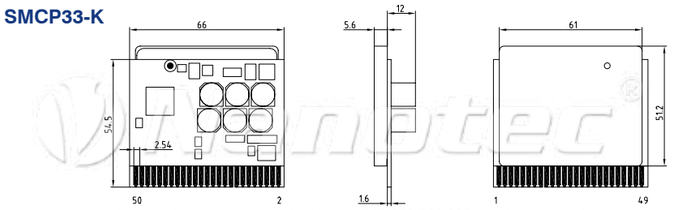
! Caution: Always use a back-up capacitor for the operating voltage of the control system. This is to be placed as close as possible to the control system. Control systems up to 4 A require a 4700µF capacitor, and control systems up to 10 A require a 10,000µF capacitor. Otherwise, there is a danger of destruction of the control system.

Outline drawing (mm)

SMCP33



SMCP33-K

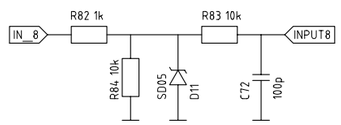


Mating connector/circuit board retainer EDAC types: 345-050-521-202 Mating connector
345-220-088 Inline plug-in unit, short
345-240-318 Encoding element between contact

Inputs/outputs (X1)

Pin	Function
1	GND
2	
3	SUPPLY + UB
4	
5	GND
6	
7	MOTOR PHASE B\
8	
9	MOTOR PHASE B
10	
11	MOTOR PHASE A\
12	
13	MOTOR PHASE A
14	
15	GND
16	
17	ENCODER INDEX
18	ENCODER CHANNEL A
19	ENCODER CHANNEL B
20	ENCODER +5V
21	TEMP_MOTOR_1
22	OUTPUT BRAKE
23	OUTPUT BALLAST
24	
25	RS485 RX-
26	RS485 RX+
27	RS485 TX-
28	RS485 TX+
29	GND
30	
31	ANALOG INPUT 1
32	ANALOG INPUT 2
33	INPUT 1
34	INPUT 2
35	INPUT 3
36	INPUT 4
37	INPUT 5
38	INPUT 6
39	INPUT 7
40	INPUT 8
41	OUTPUT 1
42	OUTPUT 2
43	OUTPUT 3
44	OUTPUT 4
45	OUTPUT 5
46	OUTPUT 6
47	OUTPUT 7
48	OUTPUT 8
49	GND
50	
ALL GNDS INTERNALLY CONNECTED	

Input circuits



Order identifier

SMCP33
SMCP33-K (with heatsink)

Fitting evaluation/motherboard:
SMCP33-EVA

Closed loop motor controller with encoder input, SMCI33

Technical data

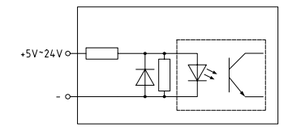
Operating voltage:	12 to 48 V DC
Phase current:	Nominal value 2 A, can be set up to a max. 3 A / phase
Interface:	RS485 or USB
Operating type:	Position, speed, flag position, cycle direction, analog, joystick
Operating mode:	1/1, 1/2, 1/4, 1/5, 1/8, 1/10, 1/32, 1/64, adaptive (1/128)
Step frequency:	0 to 50 kHz in cycle/direction mode, 0 to 25 kHz in all other modes
Inputs:	6 opto-coupler inputs (5 to 24 V)
Outputs:	3 open collectors, 30 V / 30 mA max.
Position monitoring:	Automatic error correction up to 0.9°
Current reduction:	can be set 0 to 100%
Protective circuit:	Overvoltage, undervoltage and heat sink temperature > 80 °C
Temperature range:	0 to +40 °C

* Phoenix connectors are included in the delivery.

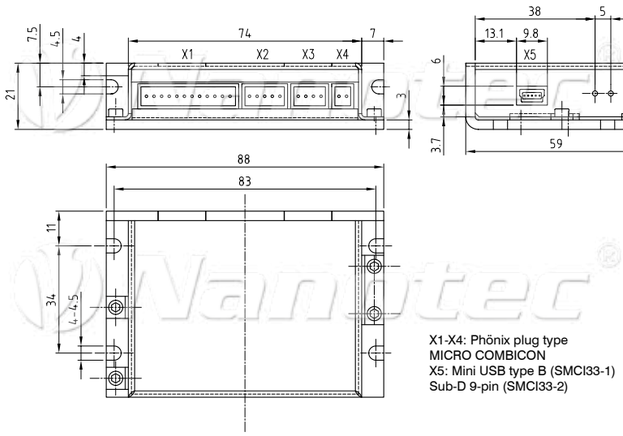
! Caution: Always use a back-up capacitor for the operating voltage of the control system. This is to be placed as close as possible to the control system. Control systems up to 4 A require a 4700µF capacitor, and control systems up to 10 A require a 10,000µF capacitor. Otherwise there is a danger of destruction of the control system.

Input circuits

Optocoupler



Outline drawing (mm)



X1-X4: Phönix plug type
MICRO COMBICON
X5: Mini USB type B (SMCI33-1)
Sub-D 9-pin (SMCI33-2)

Inputs/outputs (X1)

Pin	Function
1	Input1
2	Input2
3	Input3
4	Input4
5	Input5
6	Input6
7	Com
8	Output 1
9	Output 2
10	Output 3
11	Analog In
12	GND

Encoder (X2)

Pin	Function
1	+5 V
2	CH-B
3	CH-A
4	INDEX
5	GND

Motor connection (X3)

Pin	Function
1	Motor coil A
2	Motor coil A\
3	Motor coil B\
4	Motor coil B

Supply (X4)

Pin	Function
1	UB24-48V
2	GND

SMCI33-2: RS485 (X5)

Pin	Function
1	NC
2	RX+
3	+5 V
4	TX+
5	N.C.
6	N.C.
7	RX-
8	GND
9	TX-

SMCI33-1: USB (X5)
USB standard

Order identifier

SMCI33 -
1= USB
2= RS485

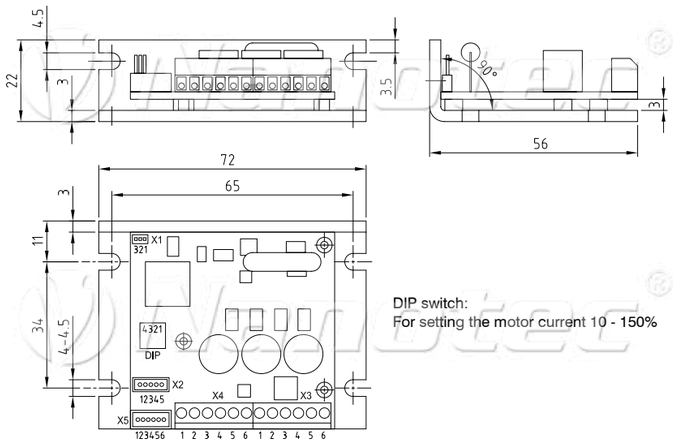
Closed loop motor controller with encoder input, SMCI35

Technical data

Operating voltage:	12 to 48 V DC
Phase current:	max. 6 A
Interface:	TTL-RS232 (3.3 V)
Operating type:	Position, speed, flag position, cycle direction, analog, joystick
Operating mode:	1/1, 1/2, 1/4, 1/5, 1/8, 1/10, 1/32, 1/64, adaptive (1/128)
Step frequency:	16 kHz in full step; in microstep, corresponding multiples (e.g. up to 1 MHz at 1/64)
Inputs:	6 digital inputs (TTL), 1 analog input +10 / - 10 V
Outputs:	3 digital outputs (TTL)
Position monitoring:	Yes, depending on rotary encoder
Current reduction:	can be adjusted from 0 to 100%
Protective circuit:	Overvoltage, undervoltage and heat sink temperature > 80 °C
Temperature range:	0 to + 40 °C

Caution: Always use a back-up capacitor for the operating voltage of the control system. This is to be placed as close as possible to the control system. Control systems up to 4 A require a 4700µF capacitor, and control systems up to 10 A require a 10,000µF capacitor. Otherwise, there is a danger of destruction of the control system.

Outline drawing (mm)



Communication (X1)

Pin	Function*	Wire color (ZK-RS232-USB-3.3V)
1	GND	Black
2	TX	Yellow
3	RX	Orange

Encoder (X2) JST-ZHR 5

Pin	Function*
1	GND
2	CH-B
3	INDEX
4	CH-A
5	+5 V

Motor and supply (X3)

Pin	Function*
1	Motor coil A
2	Motor coil A\
3	Motor coil B
4	Motor coil B\
5	UB 24-48 V
6	GND

Inputs/outputs (X4)

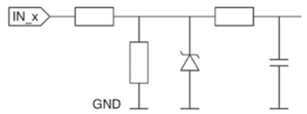
Pin	Function*	Function on delivery
1	Output 1	
2	Input 6	CLOCK
3	Input 5	DIRECTION
4	Input 4	ENABLE
5	Analog in 1	
6	GND	

Inputs/outputs (X5) JST-ZHR 6

Pin	Function*
1	GND
2	Output 3
3	Output 2
4	Input 3
5	Input 2
6	Input 1

*** from the perspective of the connected controller**

Input circuits



Order identifier

SMCI35

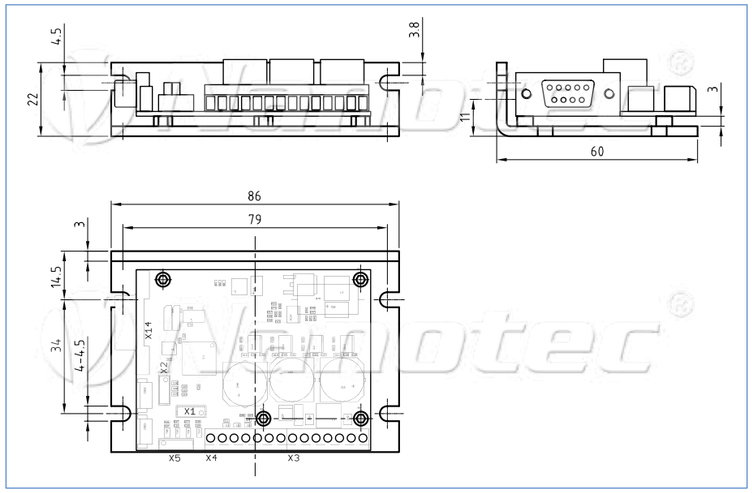
Closed loop motor controller with encoder input, SMCI36

Technical data

Operating voltage:	12 to 72 V DC
Phase current:	Nominal voltage 6 A, max. 9 A (eff)
Interface:	RS485 4-wire or CANopen
Operating type:	RS485: Position, speed, flag position, cycle direction, analog, joystick CANopen: Position, homing mode, velocity mode, interpolated position mode (in compliance with CAN standard DS402)
Operating mode:	1/1, 1/2, 1/4, 1/5, 1/8, 1/10, 1/32, 1/64, adaptive microstep, Feed constant
Step frequency:	16 kHz in full step, corresponding multiples in microstep (e.g. up to 1 MHz at 1/64)
Inputs:	6 digital inputs (TTL), 1 analog input +10 / - 10 V
Outputs:	3 digital outputs (open drain)
Position monitoring:	Yes, depending on rotary encoder
Current reduction:	can be adjusted from 0 to 100%
Protective circuit:	Overvoltage, undervoltage and heat sink temperature > 75 °C
Temperature range:	0 to + 40 °C

Caution: Always use a back-up capacitor for the operating voltage of the control system. This is to be placed as close as possible to the control system. Control systems up to 4 A require a 4700µF capacitor, and control systems up to 10 A require a 10,000µF capacitor. Othewise, there is a danger of destruction of the control system.

Outline drawing (mm)



Hall sensor (X1)

Pin	Function*
1	GND
2	Hall 1
3	Hall 2
4	Hall 3
5	+5 V

Encoder (X2)

Pin	Function*
1	GND
2	CH-B
3	INDEX
4	CH-A
5	+5 V

Motor and supply (X3)

Pin	Function* Stepper motor	BLDC
1	GND	GND
2	Motor coil A	V
3	Motor coil A\	U
4	Motor coil B	W
5	Motor coil B\	n.c.
6	72 V	72 V
7	GND	GND

Inputs/outputs (X4)

Pin	Function*
1	GND
2	Output 1
3	Input 6
4	Input 5
5	Input 4
6	Analog in 1
7	GND

Inputs/outputs (X5)

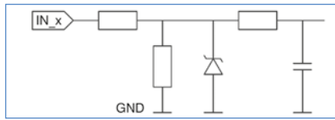
Pin	Function*
1	GND
2	Output 3
3	Output 2
4	Input 3
5	Input 2
6	Input 1

Communication (X14)

Pin	Function*
1	n.c.
2	Rx+ / CAN-
3	GND
4	Tx+
5	n.c.
6	GND
7	CAN +
8	GND
9	Tx-

*** from the perspective of the connected controller**

Input circuits



Order identifier

SMCI36

Closed loop motor controller with encoder input, SMCI47-S

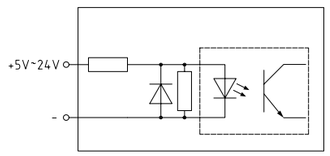
Technical data

Operating voltage:	24 to 48 V DC
Phase current:	Nominal value 7.0 A, can be set up to a max. 10.5 A / phase
Interface:	RS485, CANopen
Operating type:	Position, speed, flag position, cycle direction, analog, joystick CANopen: Position, homing mode, velocity mode, interpolated position mode
Operating mode:	1/1, 1/2, 1/4, 1/5, 1/8, 1/10, 1/32, 1/64, adaptive (1/128)
Step frequency:	0 to 50 kHz in cycle/direction mode, 0 to 25 kHz in all other modes
Inputs:	6 opto-coupler inputs (5 to 24 V)
Outputs:	3 open collectors, 30 V / 2 A max. 1 output for brake, max. 1.5 A
Position monitoring:	Automatic error correction up to 0.9°
Current reduction:	can be set 0 to 100%
Protective circuit:	Overvoltage, undervoltage and heat sink temperature > 80 °C
Temperature range:	0 to + 40 °C

* Phoenix connectors are included in the delivery.

Input circuits

Optocoupler



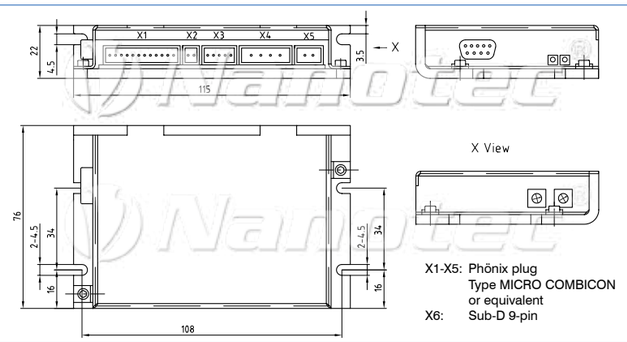
Caution: Always use a back-up capacitor for the operating voltage of the control system. This is to be placed as close as possible to the control system. Control systems up to 4 A require a 4700µF capacitor, and control systems up to 10 A require a 10,000µF capacitor. Otherwise, there is a danger of destruction of the control system.

Order identifier

SMCI47-S-

2= RS485
3= CANopen

Outline drawing (mm)



X1-X5: Phönix plug
Type MICRO COMBICON
or equivalent
X6: Sub-D 9-pin

Inputs/outputs (X1)

Pin	Function
1	Input1
2	Input2
3	Input3
4	Input4
5	Input5
6	Input6
7	Signal GND
8	Output 1
9	Output 2
10	Output 3
11	Analog In
12	GND

Brake (X2)

Pin	Function
1	Brake
2	GND

Encoder (X3)

Pin	Function
1	+5 V
2	CH-B
3	CH-A
4	INDEX
5	GND

Motor connection (X4)

Pin	Function
1	Motor coil A
2	Motor coil A\
3	Motor coil B\
4	Motor coil B

Supply (X5)

Pin	Function
1	UB24-48V
2	GND

SMCI47-S-2: RS485 (X6)

Pin	Function
1	NC
2	Rx+
3	+5 V
4	Tx+
5	NC
6	NC
7	Rx-
8	GND
9	Tx-

SMCI47-S-3: CAN (X6)

Pin	Function
1	NC
2	CAN low (CAN-)
3	CAN Ground (internally connected with pin 6)
4	NC
5	NC
6	CAN Ground (internally connected with pin 3)
7	CAN high (CAN+)
8	NC
9	Supply Vcc to 30V (used for safety feature)

Notes

Options

Motor box: Over 4,000 possibilities available ex warehouse

From our wide-ranging delivery program of stepper motors and BLDC motors in many sizes and windings and a large palette of accessories consisting of gears, safety brakes, optical encoders and other options such as vibration dampers, shaft couplers, connecting cables, etc., we can build the optimum drive for you within a few days. Over 4,000 possible combinations are possible with our stepper motor box system.

Also available for other sizes

Size 20 mm

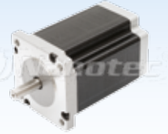
Size 42 mm

Size 60 mm

Size 86 mm

Size 110 mm

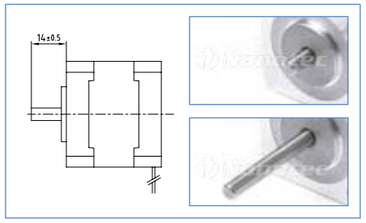
Example: ST5918 (NEMA 23) stepper motor with options

Gear	Motor	Brake	Encoder
 GPLE precision gear series from 22 to 80 mm, long expected service life	 Hybrid stepper motors with large performance range at reasonable prices	 BKE series safety brake for different motor sizes	 New WEDS5541 1000 incr./rev encoder series
 GSGE angular gear series for Nema 23 and Nema 34 motors	 BLDC motors (22 to 86 mm) for high speed and dynamics	 Customer-specific brakes are also possible (up to 9 Nm)	 Magnetic encoder, customized for integration
 Economy planetary gear series GPLL, cost-effective for large series (22 to 56 mm)	 Economic permanent magnet stepper motors from a size of 6 mm	 BL safety brake series economically in the series	 NOE1 opt. encoder, 20 mm diameter

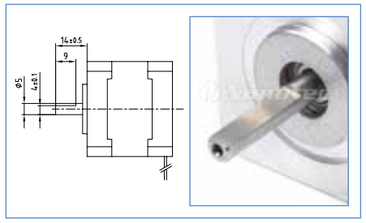
Special shaft versions for all motors

Adapted, ready to assemble shaft versions allow the constructor and assembly team fast, economic and reliable machine and device adaptation.
Other examples and details - see website: www.nanotec.de
Depending on the complexity of the machine setting, we offer machining from 1, 25 or 250 pieces.
Not all machining options are available for all motor series.

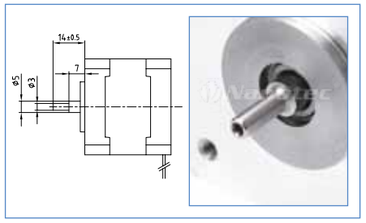
Shorter (longer) shaft — min. 1 unit



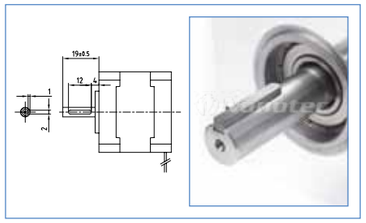
Flat-sided shaft (D-cut) — min. 1 unit



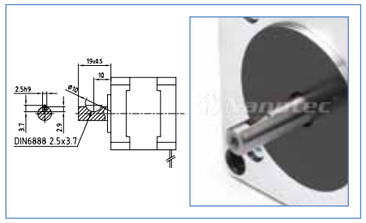
Thinner shaft — min. 1 unit



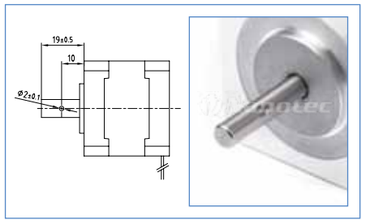
Shaft with featherkey notch — min. 1 unit



Shaft with Woodruff key notch — min. 1 unit



Motor shaft with side-drilled hole — min. 1 unit



Bigger shaft — on req.

Larger or thicker shafts are used primarily to enable higher radial forces.
Possible for all motors of the ST and DB series.

Shaft with groove — min. 1 unit

Motors with shaft groove facilitate the attachment of safety disks for axial fixing of timing pulleys, spur gears, etc.
Possible for all motors of the ST and DB series.

Hollow shaft — on req.

As well as the actual drive, hollow shafts also enable the feeding of cables, tubes or even laser beams through the motor.
Possible for selected motors of the ST series.

Motor shaft with timing belt wheel — on req.

Motors with pinion or direct gearing mounted on the motor shaft considerably facilitate direct mounting on existing reduction ratios, gears provided by the customer, linear axes etc.

Shaft with metric thread — on req.

Not only is a thread useful for fixing rotating parts on the motor shaft, but creative constructors also use this low-priced and simple method for the realization of a linear positioning drive with low positioning speed.

Toothed shaft — on req.

Motors with a toothed shaft facilitate direct mounting on existing reduction ratios, gears, etc. Direct gearing is the best technical and most economical solution for many applications.

Special transmission elements — on req.

In addition to standard-drive elements, Nanotec also offers its stepper and servomotors with a large number of other transmission elements made of a wide variety of different materials.

Shaft with spur gear/pinion — on req.

Motors withpinion or direct gearing mounted on the motor shaft considerably facilitate direct mounting on existing reduction ratios, gears, toothed racks, etc.

Shaft with worm gear — on req.

Motors with installed worm gear can be installed at a 90° angle to the load, which has a very advantageous effect on some applications. They also provide great reduction ratios in a small amount of space.

Cable assembly

Customer-specific plug versions and cable fabrication enable for the design engineering and assembly team a simple, quick, cost-effective and reliable electric connection to the machine. Nanotec offers a wide variety of different plugs for the lowest cost and most secure solution. With orders of 100 pieces or more, the plugs and cable fabrication can be done very cost-effectively.

with different connectors

JST connectors

JST connectors

Berg connectors

Lumberg connectors

AMP connectors

Wago connectors

Insulation displacement connecting technology

Sub-D connectors

Sub-D connectors

M12 connectors

with different cable assemblies

Heat shrink sleeving

Protective braid

Braiding

with integrated plug

Twintus connector

M12 connectors

JST connectors

M12 connectors

Optical encoder - WEDS/WEDL series

Features

- Low-priced
- Resolution: 500 increments/rotation. 1000 increments/rev.
- Compact housing (also for hollow shaft with 10 mm diameter)
- TTL-compatible
- 3-channel (A/B track and index signal)
- Easy installation
- For 5 mm, 6.35 mm and 10 mm shaft diameter (hollow shaft)

The encoders of the WEDS/WEDL5541 series are high-performance 3-channel incremental encoders. The module contains the transmitter with LED source, the receiver and the code washer, which rotates between the transmitter and the receiver. The signals spread over a driver component are output by the WEDL encoders as differential signals, which increases the interference immunity. The interface for the application forms a plug-in flat-band connector or, optionally, a shielded round cable.

Technical specification

Electrical specification	WEDS	WEDL
Signal form, output	Square wave signal	
Output signals	Phase A, B, I	Phase A, A\, B, B\, I, I\
Current consumption	≤ 60 mA	
Output current	0 ~ 5 mA	
Limit frequency	100 KHz	
Phase shift of the output signals	90° ± 45°	
Connection voltage	5 V DC	
Signal level	VH 85% VCC, VL ≤ 0.3 V	
Number of pulses per revolution	500, 1000 (others on request)	

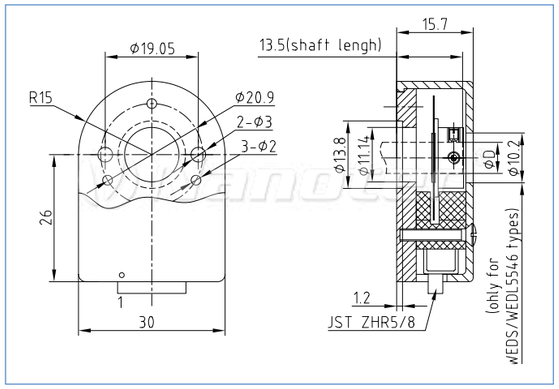
Technical specification

Mechanical specification	WEDS/WEDL
Mass inertia of the code wheel	Approx. 0.6 g cm²
Impact resistance	980 m/s², 6 ms, 2 hours each in XYZ
Vibration test	50 m/s², 10 ~ 200 Hz, 2 hours each in XYZ
Average service life	MTBF 50000 h (+25 °C, 2000 rpm)
Weight	Approx. 20 g (with 0.5 meter cable)
Ambient conditions	
Operating humidity	30 ~ 85 % (no condensation)
Storage temperature	-40 °C ~ 100 °C
Working temperature	-25 °C ~ 100 °C

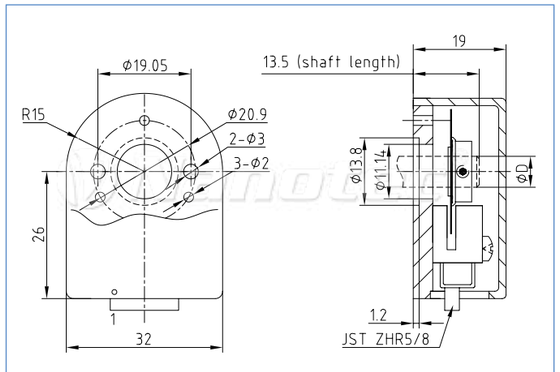
Connector configuration

Driver output	0 V	I	A	Vcc	B			
Coding system of the flat ribbon cable	1 (red)	2	3	4	5			
Core color WEDS-9000 cable	Black	Yellow	Green	Red	White			
Line driver output	0 V	Vcc	A	A\	B\	B	I\	I
Coding system of the flat ribbon cable	1 (red)	2	3	4	5	6	7	8
Core color WEDL-9000 cable	Black	Red	Green	Brown	Gray	White	Yellow	Orange

WEDS/WEDL 500 incr./rev., dimensioned drawing in (mm)

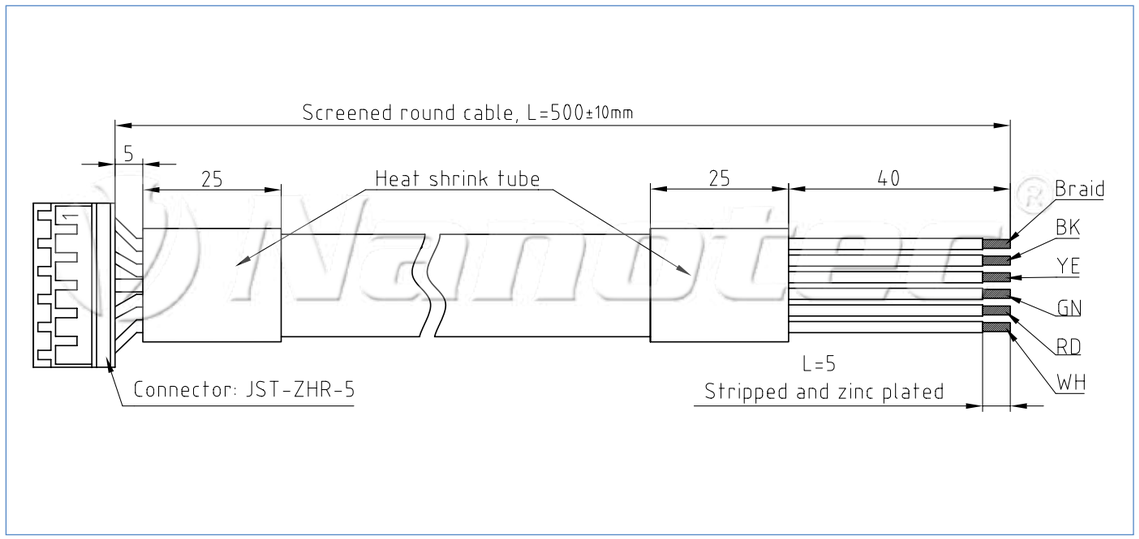


WEDS/WEDL 1000 incr./rev., dimensioned drawing in (mm)

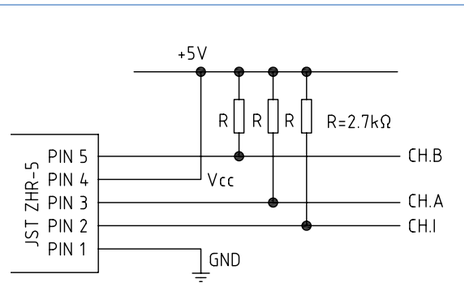


Optical signal generator: Standard encoder for stepper motor attachment				
Order identifier	**Pulses per revolution**	**for shaft diameter (mm)**	**Type**	**Plug**
WEDS5541-A14	500	5.00		JST-ZHR-5
WEDS5541-A06	500	6.35		
WEDS5546-A10	500	10.00	Hollow shaft	
WEDS5541-B14	1000	5.00		
WEDS5541-B06	1000	6.35		
Encoder with line controller (for extremely interference-proof operating conditions or long supply cables)				
WEDL5541-A14	500	5.00		JST-ZHR-8
WEDL5541-A06	500	6.35		
WEDL5546-A10	500	10.00	Hollow shaft	
WEDL5541-B14	1000	5.00		
WEDL5541-B06	1000	6.35		
Flat ribbon cable, L=500		**Screened round cable, L=500**		
ZK-WEDS-5-500		ZK-WEDS-5-500-S		JST-ZHR-5
ZK-WEDL-8-500		ZK-WEDL-8-500-S		JST-ZHR-8

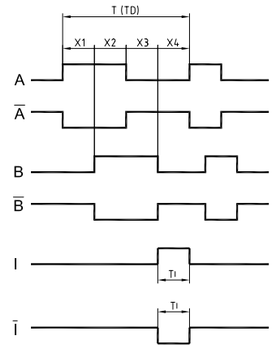
ZK-WEDS-5/8-500-S



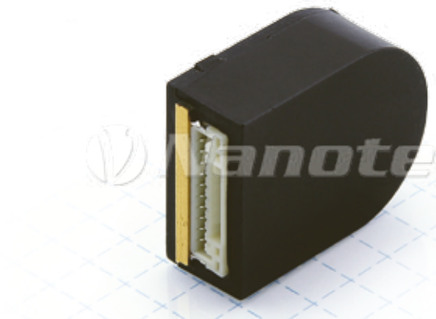
WEDS encoder connector configuration



WEDL encoder with line driver output signals



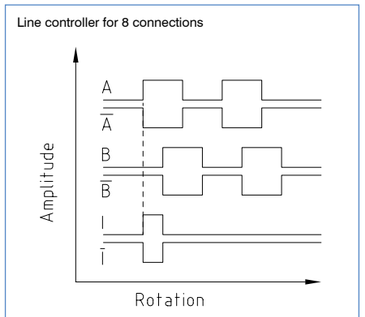
Optical encoder - NOE1 series



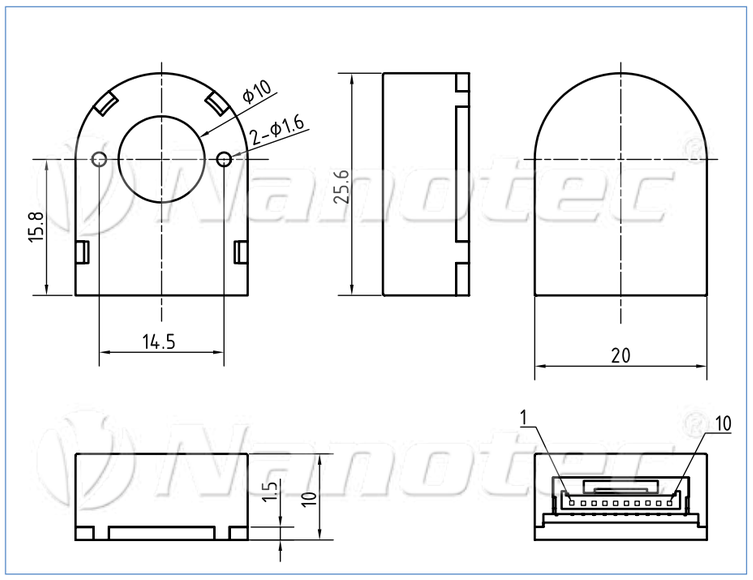
Technical data

Resolution:	500, 1000, 2000 pulses/revolution
Signal shape:	Square wave signal
Output signals:	Phase A, A\, B, B\, I, I\
Operating voltage:	5 V DC (7 V DC max.)
Current consumption:	typical 100 mA
Limit frequency:	60 KHz
Limit speed:	6600 rpm
Pulse width:	180° ± 50°
Phase shift:	90° ± 50°
Signal level:	Low 0 V, high operating voltage -0.5 V
Max. output current per channel:	± 150mA, recommended working current ± 20 mA
Operating temperature:	85 to -20 °C
Storage temperature:	85 to -40 °C
Air humidity:	Max. 90%, non-condensing

Output signals



NOE1 outline drawing (mm)



Pin assignment / connecting cable

10 pin JST GH		ZK-NOE1-10-500-S
Pin No.	**Function**	**Color**
1	GND	green/white(shielding)
2	A	Green
3	A\	Brown
4	B\	Gray
5	B	White
6	I\	Yellow
7	I	Orange
8	GND	Black
9	+5 V	Red
10	GND	green/white(shielding)

Order identifier

NOE1-05-

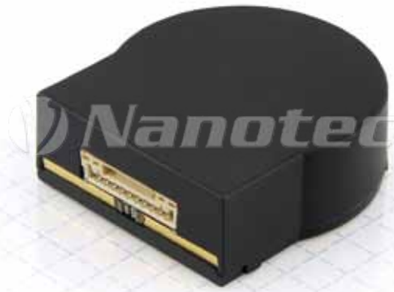
A12 = 500 pulses/rev. for shafts Ø (mm) 6
A14 = 500 pulses/rev. for shafts Ø (mm) 6
B12 = 1000 pulses/rev. for shafts Ø (mm) 5
B14 = 1000 pulses/rev. for shafts Ø (mm) 6
C12 = 2000 pulses/rev. for shafts Ø (mm) 5
C14 = 2000 pulses/rev. for shafts Ø (mm) 6

Connection cable

ZK-NOE1-10-500-S

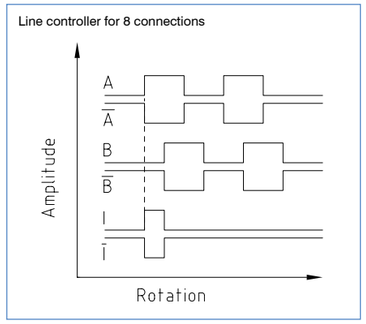
Shielded round cable L=500 mm

Optical encoder - NOE2 series

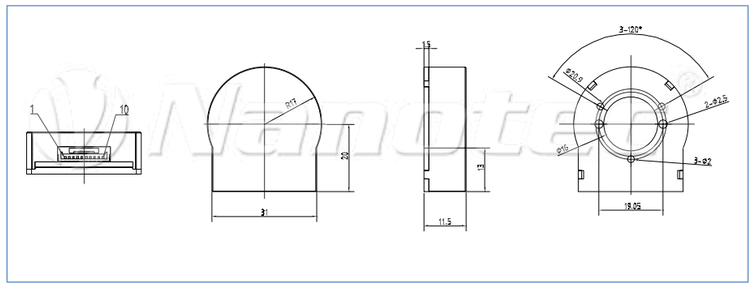


Technical data	NOE2-05	NOE2-24
Resolution:	1000, 2000, 4000 pulses/revolution	1000, 2000, 4000 pulses/revolution
Signal shape:	Square wave signal	Square wave signal
Output signals:	Phase A, A\, B, B\, I, I\	Phase A, A\, B, B\, I, I\
Operating voltage:	DC 4.5V to 5.5V	24 VDC
Current consumption:	typical 30 mA	Typ. 15mA
Limit frequency:	60 KHz	60 KHz
Limit speed:	3600 rpm	3600 rpm
Pulse width:	180° ± 30°e	180° ± 30°e
Phase shift:	90° ± 18°e	90° ± 18°e
Signal level:	Low 0V, High: Vcc-0.5V	Low 0V, High: Vcc-0.5V
Max. output current per channel:	150mA,	200mA,
Operating temperature:	-20 to 85° C	-20 to 85° C
Storage temperature:	-40 to 85 °C	-40 to 85 °C
Air humidity:	Max. 90%, non-condensing	Max. 90%, non-condensing

Output signals



Dimensioned drawing NOE2 (mm)



Pin assignment / connecting cable

10 pin JST GH		ZK-NOE1-10-500-S
NO.	**Function**	**Color**
1	GND	Green/white (shielding)
2	A	Green
3	A\	Brown
4	B\	Gray
5	B	White
6	I\	Yellow
7	I	Orange
8	GND	Black
9	+5V (NOE2-05)/ +24V (NOE2-24)	Red
10	GND	Green/white (shielding)

+5V Optical encoder NOE2-05: Standard encoder for stepper motor mounting		
Order identifier	**PPR**	**for shafts Ø (mm)**
NOE2-05-B14	1000	5.00
NOE2-05-B06	1000	6.35
NOE2-05-B10	1000	10.00
NOE2-05-B15	1000	15.00
NOE2-05-C14	2000	5.00
NOE2-05-C06	2000	6.35
NOE2-05-C10	2000	10.00
NOE2-05-C15	2000	15.00
NOE2-05-K14	4000	5.00
NOE2-05-K06	4000	6.35
NOE2-05-K10	4000	10.00
NOE2-05-K15	4000	15.00

+24V Optical encoder NOE2-24: Standard encoder for stepper motor attachment		
Order identifier	**PPR**	**for shafts Ø (mm)**
NOE2-24-B14	1000	5.00
NOE2-24-B06	1000	6.35
NOE2-24-B10	1000	10.00
NOE2-24-B15	1000	15.00
NOE2-24-C14	2000	5.00
NOE2-24-C06	2000	6.35
NOE2-24-C10	2000	10.00
NOE2-24-C15	2000	15.00
NOE2-24-K14	4000	5.00
NOE2-24-K06	4000	6.35
NOE2-24-K10	4000	10.00
NOE2-24-K15	4000	15.00

Notes

Gears

Application fields:

The compact and proven gears from Nanotec are ideal for use in the following tasks:

- Increase and matching of the output torques
  MdGetr. = MdMot x i x η
- Reduction of the output torque
  $\mathbf{n_2 = n_{Mot} / i}$
- Quadratic reduction of ext. moments of inertia
  $\mathbf{J_{red} = J_{ex} / i^2}$
- Reduction of the step angle
  $\mathbf{\alpha_{Outp} = \alpha_{Mot} / i}$

Advantages

- Large speed reduction bandwidth
- Wide torque spectrum
- High running smoothness
- Maintenance-free due to permanent lubrication
- Versatile combination options

Caution: When selecting the gearbox, the following criteria is to be noted:

a) Output torques
Output torques increase proportionally with the reduction, and can lead to damage to the gear. (max. permitted output values are not to be exceeded!)

b) Radial and axial forces
Radial and axial forces mainly impair the expected service life of the bearing and the shaft strength in some cases.

c) Working temperatures
Working temperatures affect the thermal loading of the bearing.

d) Load types
Various types of load lead to high gear, shaft and bearing stresses and hence reduce the service life.

Which type of gear is advantageous?

1) Planetary gear	due to the triple meshing, these gears offer the highest torque at comparable volume and have the highest efficiency with concentric shaft output.
2) Worm gear	Enable smooth running performance and, due to the 90° force transfer, have a low installation depth and offer a self-locking torque due to continuous power transmission at higher reduction ratios.

Precision planetary gear GPLE

The low-play planetary gear from Nanotec are developed to state of the art in gearing technology and are manufactured to DIN/ISO 9001.

Advantages

- High output torques
- High torsional rigidity
- Low circumferential backlash
- High admissible axial and radial shaft loading
- Low running noise
- Easy motor/gear assembly
- Protection class IP54
- 30,000 hours service life, 10,000 hours for GPLE22

Order identifier

GPLE40 - ◯ - ◯

Size

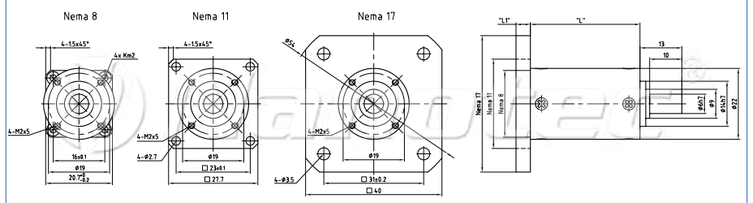
1S = 1-stage
2S = 2-stage
3S = 3-stage

Reduction ratio i

When ordering, it is important to specify the motor onto which the gear will be mounted.

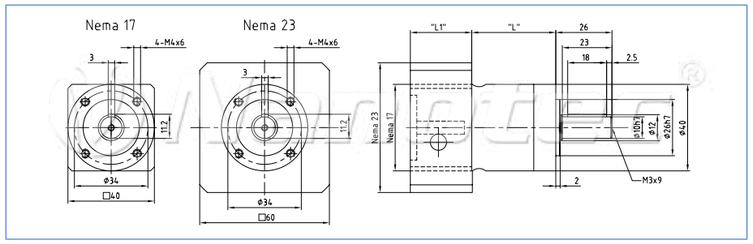
GPLE22

Outline drawing (mm)



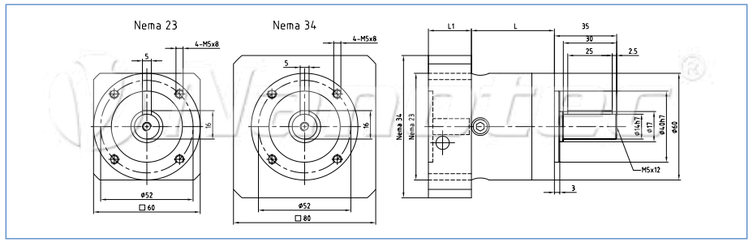
GPLE40

Outline drawing (mm)



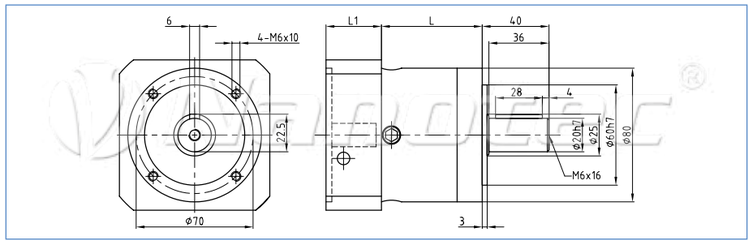
GPLE60

Outline drawing (mm)



GPLE80

Outline drawing (mm)



Precision planetary gear GPLE

Available versions (others on request)												
Type		Backlash Angular minutes	Weight kg	Length L mm	Efficiency at full load *3.	Reduction ratio	Output torque Nm Nominal value(*1)	Output torque Nm Max. value (*2)	Moment of inertia kg mm²	Intermediate flange L1 mm	Combination option with motor	permissible radial/axial shaft load (N) 10,000 h service life (30,000 h service life)
GPLE22	2-stage	<55	0.1	34	80	9 12 15	1.5	n.a.	0.09	4.5	ST20, ST28 ST41,ST42… (Nema 8,11,17)	20/20
GPLE40	1-stage	<15	0.35	39	98 98 98 96	3 4 5 8	11.0 15.0 14.0 6.0	17.6 24 22 10	3.1 2.2 1.9 1.7	27.5	ST41, ST42, DB42… (Nema 17)	200/200
	2-stage	<19	0.45	52	97 96 96 96 96 95 95 94 86	9 12 15 16 20 25 32 40 64	6.5 20.0 18.0 20.0 20.0 18.0 20.0 18.0 7.5	26 32 29 32 32 29 32 29 12	3.0 2.9 2.3 2.2 1.9 1.9 1.7 1.6 1.6			
	3-stage	<22	0.55	64.5	92 90 89 87 86 82 81 76 48	60 80 100 120 160 200 256 320 512	20.0 20.0 20.0 18.0 20.0 18.0 20.0 18.0 7.5	32 32 32 29 32 29 32 29 12	2.9 1.9 1.9 2.9 1.6 1.6 1.6 1.6 1.6	24.5	ST57, ST59, DB57… (Nema23) (cannot be combined with ST5918D	(160/160)
GPLE60	1-stage	<12	0.9	47	98 98 98 97	3 4 5 8	28.0 38.0 40.0 18.0	45 61 64 29	13.5 9.3 7.8 6.5	24.5	ST57, ST59, DB57… (Nema 23) (for ST5918D not all variants available)	500/600
	2-stage	<15	1.1	59	97 96 96 96 96 95 95 94 87	9 12 15 16 20 25 32 40 64	44.0 44.0 44.0 44.0 44.0 40.0 44.0 40.0 18.0	70 70 70 70 70 64 70 64 29	13.1 12.7 7.7 8.8 7.5 7.5 6.4 6.4 6.4			
	3-stage	<18	1.3	72	92 91 89 88 86 83 81 77 51	60 80 100 120 160 200 256 320 512	44.0 44.0 44.0 44.0 44.0 40.0 44.0 40.0 18.0	70 70 70 70 70 64 70 64 29	7.5 7.5 7.5 6.4 6.4 6.4 6.4 6.4 6.4	33.5	ST89, DB87… (Nema 34)	(340/450)
GPLE80	1-stage	<8	2.1	60	98 98 98 97	3 4 5 8	85.0 115.0 110.0 50.0	126 184 176 80	77.0 52.0 45.0 39.0	41.5	ST89… (Nema 34)	950/1200
	2-stage	<12	2.6	77.5	97 97 96 96 96 95 95 94 89	9 12 15 16 20 25 32 40 64	130.0 120.0 110.0 120.0 110.0 110.0 120.0 110.0 50.0	208 192 176 192 192 176 192 176 80	74.0 72.0 71.0 50.0 44.0 44.0 39.0 39.0 39.0			
	3-stage	<14	3.1	95	92 91 80 89 88 85 84 80 57	60 80 100 120 160 200 256 320 512	110.0 120.0 120.0 110.0 120.0 110.0 120.0 110.0 50.0	176 192 192 176 192 176 192 176 80	51.0 50.0 44.0 70.0 39.0 39.0 39.0 39.0 39.0			(650/900)

Long-term gearing rated, hardened
Operating temperature: -25° to 90°
Service life lubricated, protection class IP54

*1. Continuous drive torque on the output shaft with swelling load of 100rpm and application factor KA=1 an operating mode S1.

*2. Admissible for 30,000 revolutions of output shaft

*3. At T2N. reference temperature 70° and n1=1000 rpm

Economy planetary gear GPLL

The GPLL series economy planetary gear is ideal for applications in which the increased torque of a motor with gearing is needed with the same construction volumes.
The slightly higher circumferential backlash is not relevant for many applications such as transport drives or positioning in one rotation direction, many controllers also already offer automatic play compensation (such as SMCI, etc.) and hence compensates the backlash electronically.

Gears

Torsional backlash: Axial/radial backlash:

GPLL22	2.5°	< = 0.3/< = 0.04 mm
GPLL40	3°	< = 0.3/< = 0.04 mm
GPLL52	3°	< = 0.3/< = 0.04 mm

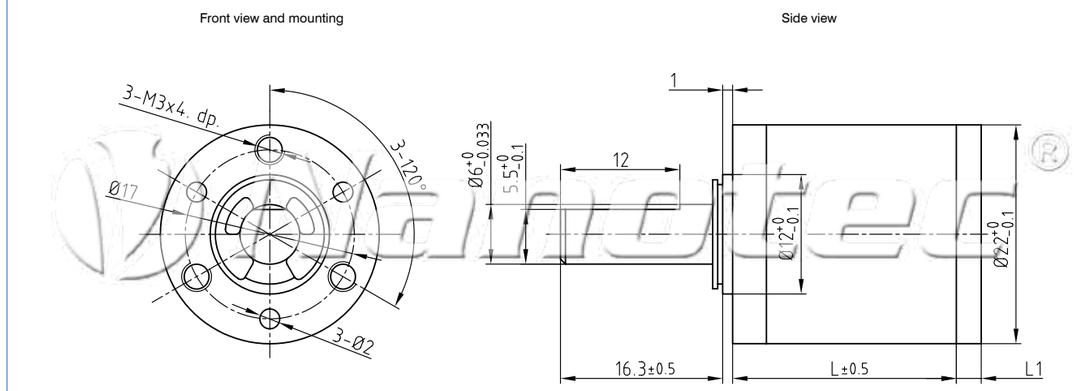
Service life Lh10 > 1000 h

Order identifier

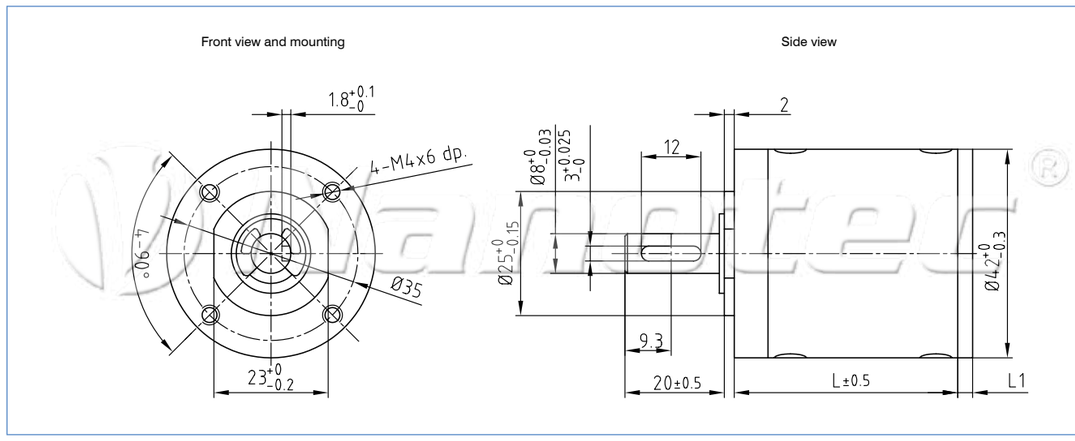
Available versions (others on request)

Type	Reduction ratio	Nom. torque Ncm	max. torqueNcm	Efficiency	Weight kg	Length mm	Intermediate flange L1 mm	Combination option with motor	axial/radial force N
GPLL22-5	5:1($4_{2/3}$:1)	20	60	80%	0.046	23.3	without	DB28	
GPLL22-25	25:1($25_{1/5}$:1)	30	90	70%	0.051	29.5	5.0	ST20, 28	7.2
GPLL22-90	90:1($89_{121/169}$:1)	40	120	60%	0.058	35.7			
GPLL40-14	14:1(14:1)	100	300	70%	0.191	39.2	6.0	ST40, 41, 42	
GPLL40-24	24:1(24:1)	100	300	70%	0.191	39.2	6.0	DB42	30/80
GPLL40-49	49:1(49:1)	180	540	60%	0.231	45.9			
GPLL52-4	4:1($4_{1/3}$:1)	150	450	80%	0.475	53.0	6.0		
GPLL52-15	15:1($15_{1/6}$:1)	500	1500	70%	0.660	68.5	6.0	ST57, 58, 59, 60	100/200
GPLL52-53	53:1($53_{1/12}$:1)	1000	3000	60%	0.850	84.0	6.0	DB57	
GPLL52-100	100:1($100_{2/7}$:1)	1000	3000	60%	0.850	84.0	(on request)	DB87	

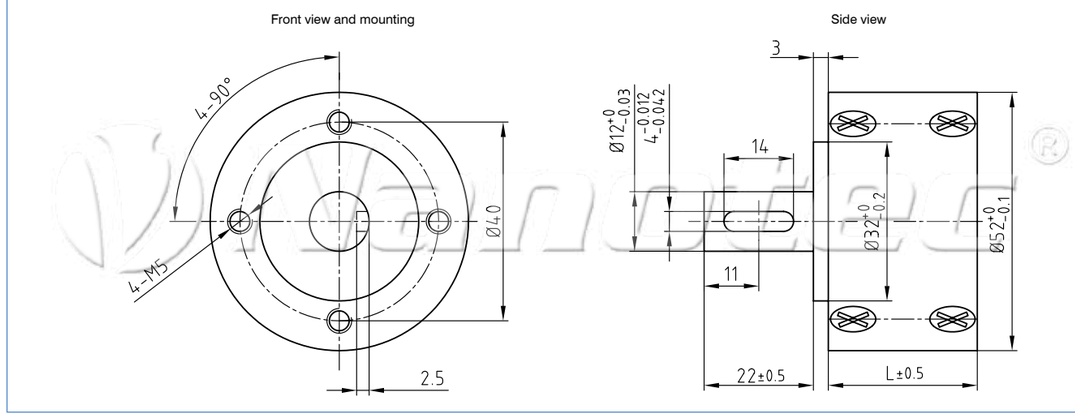
GPLL22 Outline drawing (in mm)



GPLL40 Outline drawing (in mm)



GPLL52 Outline drawing (in mm)



Worm gear GSGE

The maximum Mmax drive torques represent the load limit in continuous operation at an even load.

The output torque limits Mgrenz are statically and for short terms reliable when running, without damage to the gear occurring. The output torque limits Mgrenz represent the upper limits of the permitted load and should also not be exceeded during shocks.

Order identifier

GSGE60 -

Size

Reduction ratio i

Available as options:

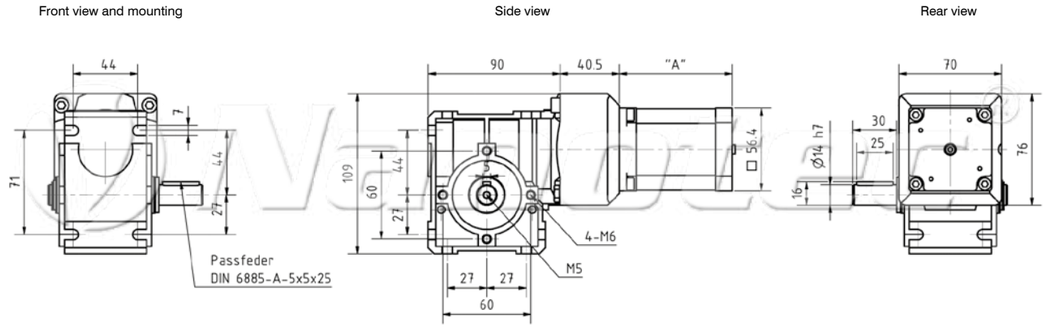
· Double shaft (order number: MG-DW-GSGE60)

· Cover hood (order number: MG-D-GSGE60)

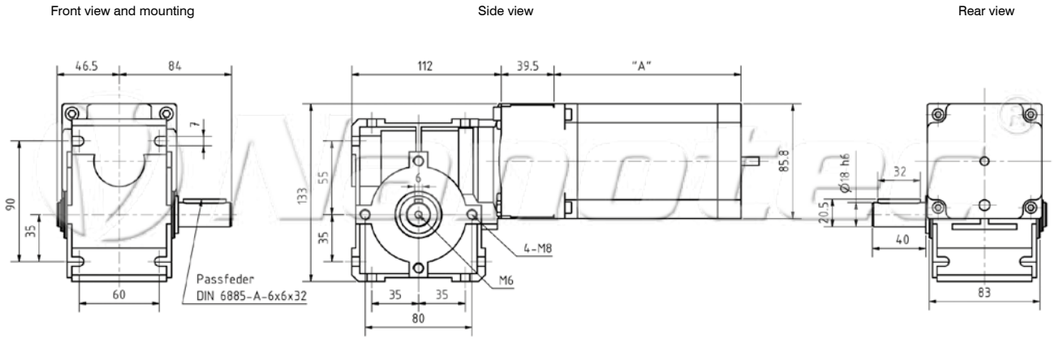
Available versions (others on request)

Type	Reduction ratio	Mgrenz output limit torque Ncm	Mmax max. output torques Ncm	Efficiency	Weight kg	Self-locking	Combination option with motor
GSGE60-5-1	5 : 1	7500	3000	86%	2.0	no	(Nema 23)
GSGE60-15-1	15 : 1	7500	3000	71%	2.0	no	(Nema 23)
GSGE60-25-1	25 : 1	7500	3000	63%	2.0	no	(Nema 23)
GSGE60-50-1	50 : 1	7500	3000	45%	2.0	yes	(Nema 23)
GSGE80-12.5-1	12.5 : 1	12500	5000	80%	3.0	no	(Nema 34)
GSGE80-25-1	25 : 1	12500	5000	68%	3.0	no	(Nema 34)
GSGE80-50-1	50 : 1	12500	5000	50%	3.0	yes	(Nema 34)

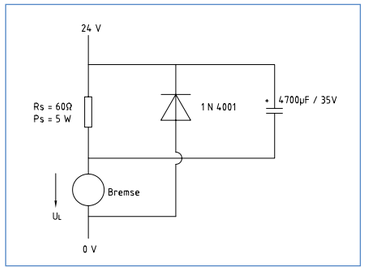
GSGE 60 outline drawing (in mm)



GSGE 80 outline drawing (in mm)



Brakes



The safety brakes from Nanotec have a compact flange design, are low-wear and are equipped with asbestos-free friction linings. They offer a simple and fast installation through the fixed, set air gap. The breaks are electromagnetically released and are used everywhere a load has to be held in position, even in the case of an interruption of the power supply. The braking power is applied by a compression spring (brake BW and BL) or a permanent magnet (brake BKE). With all brakes, a voltage of 24 V DC has to be applied during release.

Brake type BL

Technical data

Electrical data:	24 V DC / 5 W
Inertia torque:	0.01 kg/cm²
On/Off switching time:	11 ms / 17 ms
Nominal torque:	0.24 Nm
Hub:	Hole Ø5H7 with 2 grub screws M3
Fastener:	With 3 screws M2.5
Connection:	Cords L=400 mm
Weight	0.1 kg

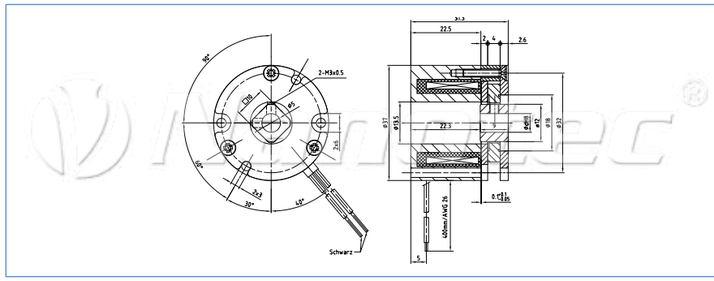
Mounting option: Series 40 motor with B shaft

Order identifier

BRAKE-BL - 0.24 - 5.0

5.0 = ID hub borehole 5.0

Outline drawing (in mm)



Brake type BW

Technical data

Electrical data:	24 V DC / 10 W
Inertia torque:	0.1 kg/cm²
On/Off switching time:	35 ms / 25 ms
Nominal torque:	1.4 Nm
Hub:	Drill hole ... H7 with 2 grub screws M4
Fastener:	with 2 stud screws M3 or M4
Connection:	Leads L = 400 mm
Weight	0.5 kg

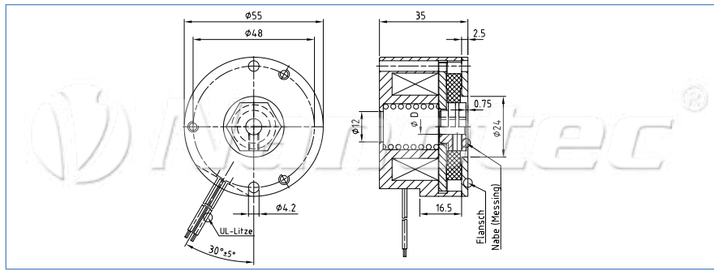
Installation option: 56 series motor with B shaft

Order identifier

BRAKE-BW - 1.4 - 6.3

6.3 = hub borehole 6.35
9.5 = hub borehole 9.525

Outline drawing (in mm)



Brakes

Integrated brakes with plug connection allow operation in tough environmental conditions (IP54) and ensure fast and mistake-free wiring.
The BKE brakes with the Nano brake module are used for this purpose.

The Nano brake module (PWM controller) reduces the power and heat losses of the brake by 35% thus enabling a higher stopping and activation time of the motor.

The anti-surge diode for the brake is also already integrated in the module.

Technical data

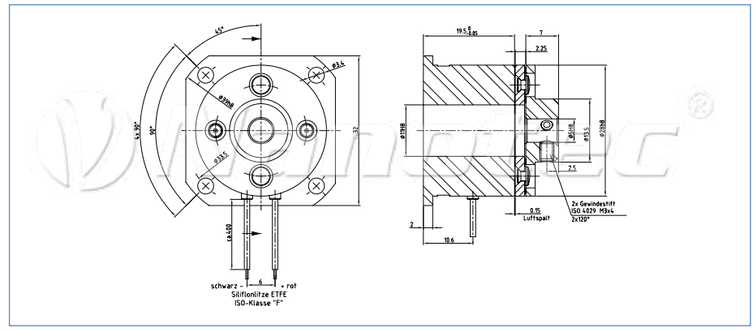
Electrical data:	24 V DC / 8 W
Inertia torque:	0.013 kg/cm²
On/Off switching time:	10 ms / 6 ms
Nominal torque:	0.4 Nm
Hub:	Drill hole ... H8 with 2 grub screws AM3x4
Fastener:	With 4 M3 screws.
Connection:	Leads L = 400 mm
Weight	0.08 kg

Order identifier

BRAKE-BKE - 0.4 - 5.0

5.0 = ID hub borehole 5.0

Outline drawing (in mm)



Technical data

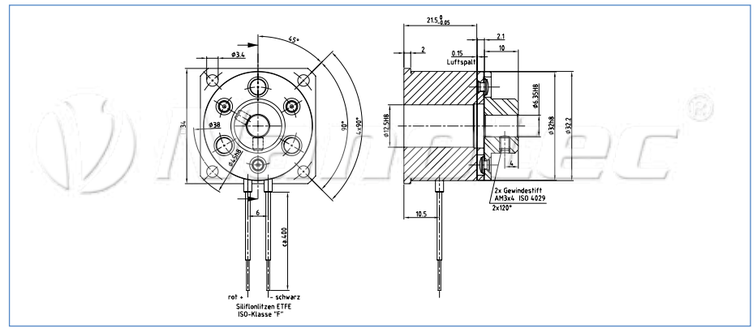
Electrical data:	24 V DC / 10 W
Inertia torque:	0.021 kg/cm²
On/Off switching time:	12 ms / 6 ms
Nominal torque:	1 Nm
Hub:	Drill hole ... H8 with 2 grub screws AM3x4
Fastener:	With 4 M3 screws.
Connection:	Leads L = 400 mm
Weight	0.11 kg

Order identifier

BRAKE-BKE - 1.0 - 6.35

6.35 = ID hub borehole 6.35

Outline drawing (in mm)



Technical data

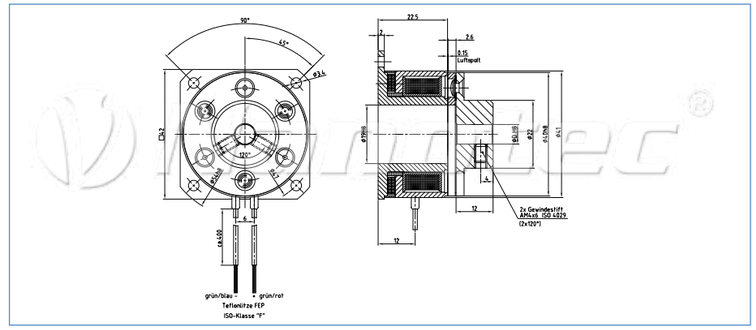
Electrical data:	24 V DC / 11 W
Inertia torque:	0.067 kg/cm²
On/Off switching time:	25 ms / 6 ms
Nominal torque:	2 Nm
Hub:	Drill hole ... H8 with 2 grub screws AM4x6
Fastener:	With 4 M3 screws.
Connection:	Leads L = 400 mm
Weight	0.185 kg

Order identifier

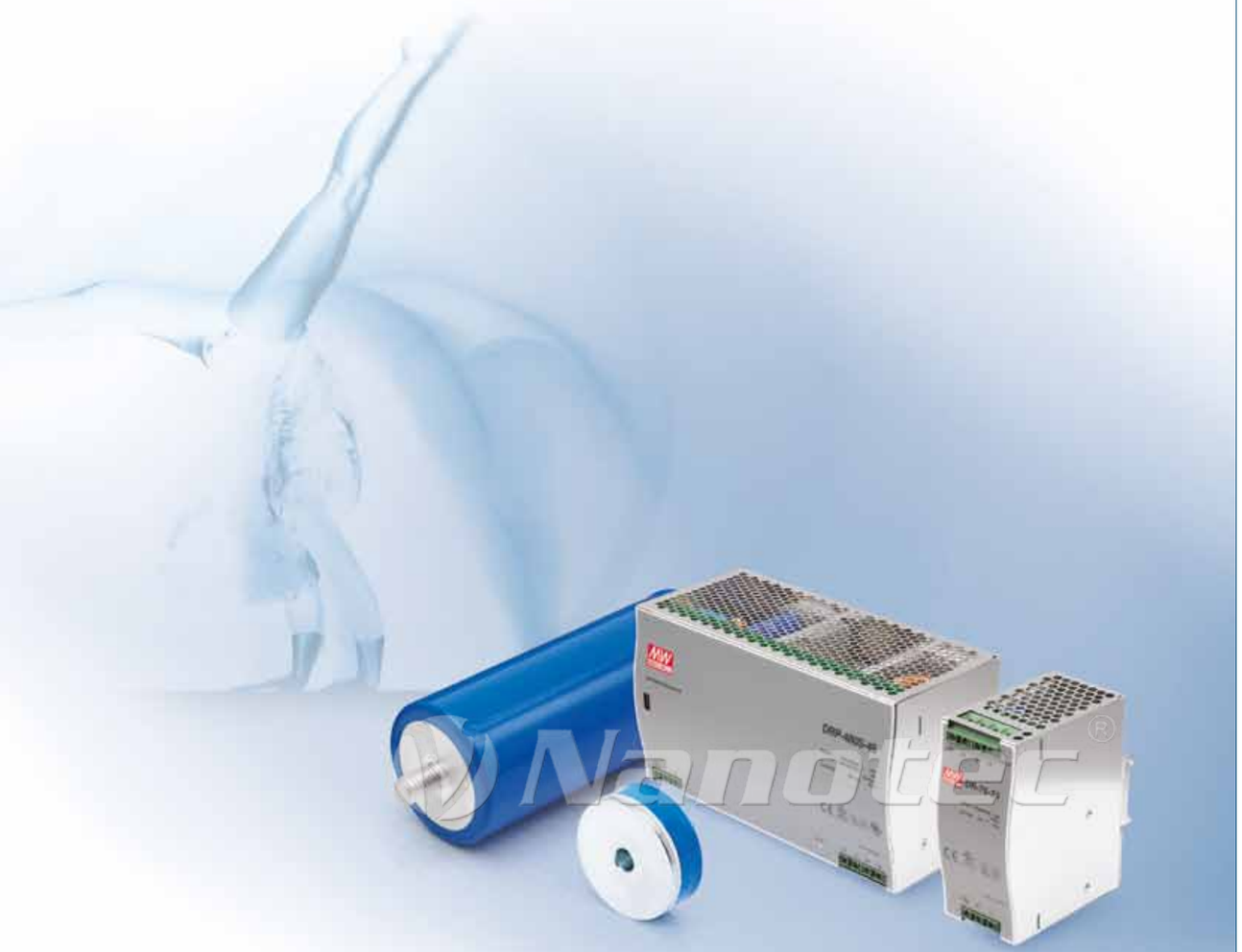
BRAKE-BKE - 2.0 - 6.35

6.35 = ID hub borehole 6.35
8.0 = ID hub borehole 8.0

Outline drawing (in mm)



Accessories



Switch-mode power supplies for DIN top hat rail 120 - 480 W (sealed construction)

Pin assignment

NTS-24 V-5 A; NTS-24 V-10 A
NTS-48 V-2.5 A; NTS-48 V-5 A

Pin	Designation	
1	out	RDY
2		
3		V^+ DC
4		V^+ DC
5		V.DC
6		V.DC
7	in	PE, grounding
8		L
9		N
	other	DC On
		DC Lo
		V_{out} Adj.

NTS-48 V-10 A

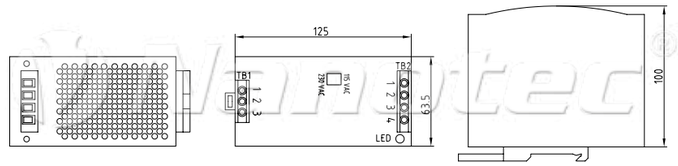
TB1 =	AC input
1 =	FG grounding
2 =	AC/N
3 =	AC/L
TB2 =	DC output
1.2 =	+V
3.4 =	-V

Technical data (all values related to 230 V AC/25 °C)

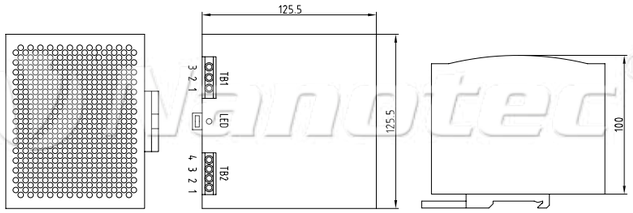
Input voltage: 180 V AC to 264 V AC
Output voltage: 24 V, 48 V
Safety: Soft start
Protective circuit: overload / undercurrent protection, over-bridging loss of power 20 ms below full load, short-circuit proof
Temperature range: -10 °C to +50 °C (up to +70 °C at 60% load)
Approvals: CE /UL / TÜV
Efficiency: 86%
Type of connection: Screw clamps
Fastening type: DIN carrying rail

Outline drawing (mm)

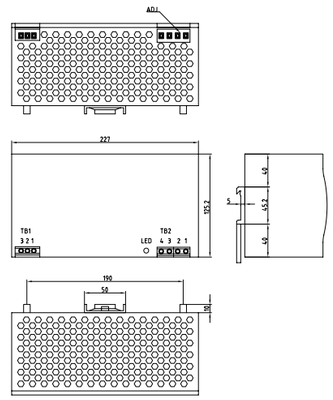
NTS-24V-5A
NTS-48V-2.5A



NTS-24V-10A
NTS-48V-5A



NTS-48V-10A



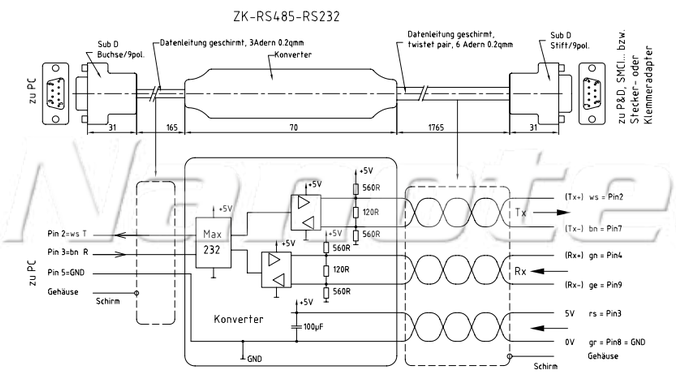
Technical data

	NTS-24V-5A(120 W)	NTS-48V-2.5A(120 W)	NTS-24V-10A(240 W)	NTS-48V-5A(240 W)	NTS-48V-10A(480 W)
Nominal input current:	1.4 A/230 V	1.4 A/230 V	2.2 A/230 V	2.2 A/230 V	4.0 A/230 V
Input current (cold start):	24 A/115 V 48 A/230 V	24 A/115 V 48 A/230 V	24 A/115 V 48 A/230 V	24 A/115 V 48 A/230 V	30 A/150 50 A/230 V
Output voltage:	24 ~ 32 V	46 ~ 57 V	24 ~ 32 V	46 ~ 57 V	48 ~ 53 V
Power output:	120 W (24 V/5 A)	120 W (48 V/2.5 A)	240 W (24 V/10.0 A)	240 W (48 V/5 A)	480 W (48 V/10 A)
Weight:	0.64 kg	0.64 kg	1.0 kg	1.0 kg	2.2 kg

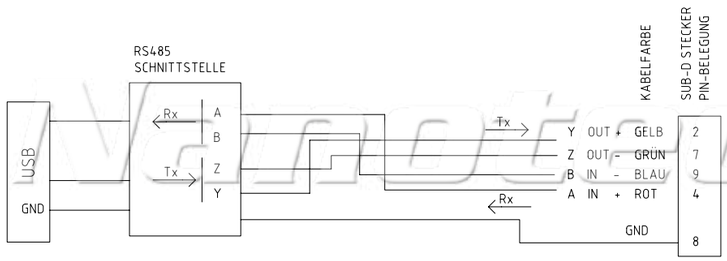
Connection cable

Order identifier	
Interface converter	
ZK-RS485-RS232	Converter from RS232 to RS485, 4-wire
ZK-RS485-USB	Converter from USB to RS485, 4-wire
ZK-RS232-USB-3.3V	Converter RS232-USB (TTL for SMCI35)

ZK-RS485-RS232

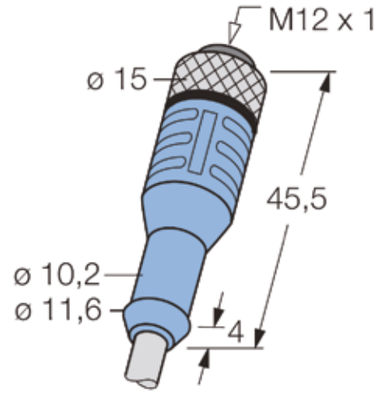


ZK-RS485-USB

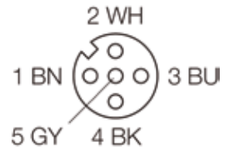


Connection cable

Order identifier	
M12 cable for AS and AD motors with encoder	
ZK-M12-8-2M-1-PUR-S	8-pin, 2 m, straight connector, shielded
ZK-M12-8-5M-1-PUR-S	8-pin, 5 m, straight connector, shielded
ZK-M12-8-2M-2-PUR-S	8-pin, 2 m, angled connector, shielded
ZK-M12-8-5M-2-PUR-S	8-pin, 5 m, angled connector, shielded

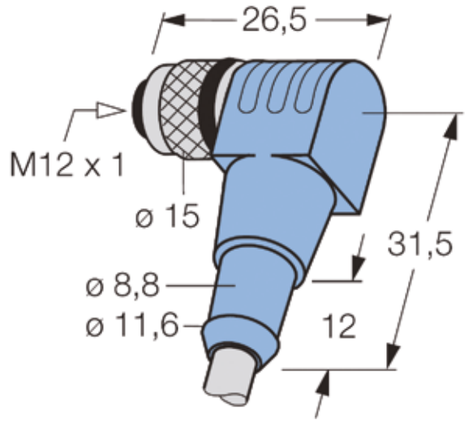


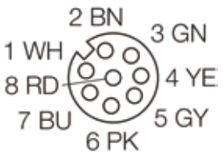
Order identifier	
M12 motor connection cable for AS motors	
ZK-M12-5-2M-1-PUR-S	5-pin, 2 m, straight connector, shielded
ZK-M12-5-5M-1-PUR-S	5-pin, 5 m, straight connector, shielded
ZK-M12-5-2M-2-PUR-S	5-pin, 2 m, angled connector, shielded
ZK-M12-5-5M-2-PUR-S	5-pin, 5 m, angled connector, shielded



No.	COLOR
1	Brown
2	White
3	Blue
4	Black
5	Gray

Shield placed on union nut





No.	COLOR
1	White
2	Brown
3	Green
4	Yellow
5	Gray
6	Pink
7	Blue
8	Red

Shield placed on union nut

Order identifier	
Diverse cable sets	
ZK-SMC11	Assembled cable set for SMC11/G/GE, L=300 mm
ZK-SMCI12	Assembled cable set for SMCI12
ZK-SMCI12-3	Assembled cable set for SMCI12 with CAN Open
ZK-USB	Programming cable for SMCI33-1

Connection cable

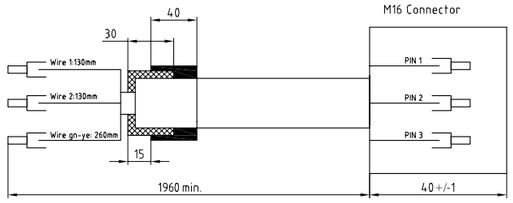
Order identifier

M16 motor cable for PD6-N8918...-S motors	
ZK-TW-3-2M	Motor cable, 3-pin, 2m, straight plug
ZK-TW-3-5M	Motor cable, 3-pin, 5m, straight plug
ZK-TW-3-10M	Motor cable, 3-pin, 10m, straight plug
ZK-TW-3-2-2 M	Motor cable, 3-pin, 2m, angled plug
ZK-TW-3-5M-2	Motor cable, 3-pin, 5m, angled plug
ZK-TW-3-10M-2	Motor cable, 3-pin, 10m, angled plug

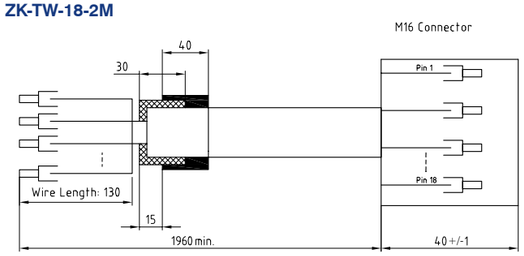
M16 signal cable for PD6-N8918…-S motors	
ZK-TW-18-2M	Motor cable, 18-pin, 2m, straight plug
ZK-TW-18-5M	Signal cable, 18-pin, 5m, straight plug
ZK-TW-18-10M	Signal cable, 18-pin, 10m, straight plug
ZK-TW-18-2M-2	Motor cable, 18-pin, 2m, angled plug
ZK-TW-18-5M-2	Motor cable, 18-pin, 5m, angled plug
ZK-TW-18-10M-2	Motor cable, 18-pin, 10m, angled plug

Outline drawing (mm)

ZK-TW-3-2M



ZK-TW-18-2M



Pin assignments: ZK-TW-3-2M, ZK-TW-18-2M

PIN/WIRE NO.	
WIRE NO./COLOR	FUNCTION
1	+VB
2	GND
3 (green/yellow)	Protective conductor

ZK-TW-18-2M		
FUNCTION	PIN	COLOR
Output 1	1	White/yellow
Output 2	2	Yellow/brown
Output 3	3	White/gray
Analog input	4	White/blue
+Vb external	5	White/pink
GND (W001)	6	Red
RS485 Tx+	7	Gray
RS485 Tx-	8	Pink
RS485 Rx-	9	Yellow
RS485 Rx+	10	Green
Input 1	11	Black
Input 2	12	Purple
Input 3	13	Gray/pink
Input 4	14	Red/blue
Input 5	15	White/green
Input 6	16	Brown/green
CAN -	17	White
CAN +	18	Brown

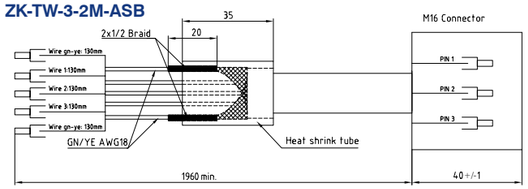
Order identifier

M16 Motor cable for ASB42, ASB87	
ZK-TW-3-2M-ASB	Motor cable, 3-pin, 2m, straight plug
ZK-TW-3-5M-ASB	Motor cable, 3-pin, 5m, straight plug
ZK-TW-3-2M-ASB-2	Motor cable, 3-pin, 2m, angled plug
ZK-TW-3-5M-ASB-2	Motor cable, 3-pin, 5m, angled plug

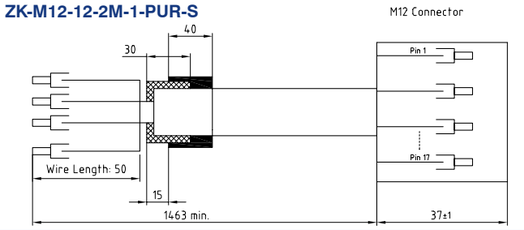
M12 signal cable for ASB42	
ZK-M12-12-2M-1-PUR-S	Signal cable, 12-pin, 2m, straight plug, shielded
ZK-M12-12-5M-1-PUR-S	Signal cable, 12-pin, 5m, straight plug, shielded
ZK-M12-12-2M-2-PUR-S	Signal cable, 12-pin, 2m, straight plug, shielded
ZK-M12-12-5M-2-PUR-S	Signal cable, 12-pin, 5m, straight plug, shielded

Outline drawing (mm)

ZK-TW-3-2M-ASB



ZK-M12-12-2M-1-PUR-S



Pin assignments: ZK-TW-3-2M, ZK-M12-12-2M

ZK-TW-3-2M-ASB	
WIRE NO./COLOR	FUNCTION
1	U
2	V
3	W

ZK-M12-12-2M		
PIN NO.	ENC./HALL	COLOR
1	GND	Brown
2	5 V	Blue
3	GND	White
4	A	Green
5	A\	Pink
6	B	Yellow
7	B\	Black
8	I	Gray
9	I\	Red
10	H1	Violet
11	H2	Gray/pink
12	H3	Red/blue

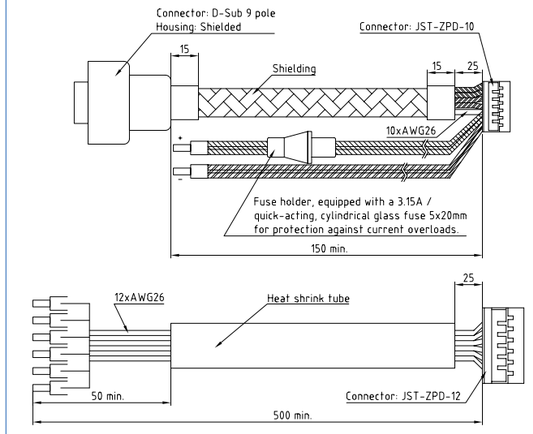
Connection cable

Order identifier

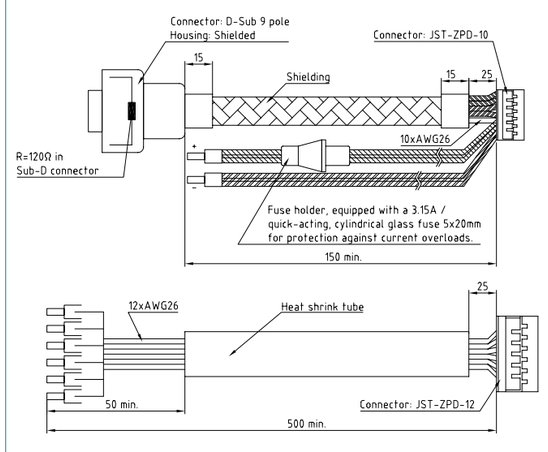
Motor cable for PD2-N4118L1804-2	Motor cable for PD2-N4118L1804-3
ZK-PD2N	ZK-PD2N-3

Outline drawing (mm)

ZK-PD2N



ZK-PD2N-3



Pin assignment: ZK-PD2N

JST ZPD-10 Housing: ZPDR-10V-S Contact:SZPD-002T-PO.3		
PIN NO.	COLOR	FUNCTION
1	Blue	GND+shielding
2		NC
3	Yellow	RS485 Rx-
4	Green	RS485 Rx+
5	Pink	RS485 Tx-
6	Gray	RS485 Tx+
7	Black	GND
8	Brown	+VB
9	Brown	+VB
10	Black	GND

JST ZPD12 Housing: ZPDR-12V-S Contact:SZPD-002T-PO.3		
PIN NO.	COLOR	FUNCTION
1	Gray/brown	GND
2	Black	Input 1
3	Violet	Input 2
4	Gray/pink	Input 3
5	Red/blue	Input 4
6	White/green	Input 5
7	Brown/green	Input 6
8	White/blue	Analog input
9	White/yellow	Output 1
10	Yellow/brown	Output 2
11	White/gray	Output 3
12	Red	GND

D-SUB FEMALE CONNECTOR		
PIN NO.	COLOR	FUNCTION
1		NC
2	Green	RS485 Rx+
3		NC
4	Gray	RS485 Tx+
5		NC
6		NC
7	Yellow	RS485 Rx-
8	Blue	GND
9	Pink	RS485 Tx-
housing	shielding	

EXTERNAL I/O	
COLOR	FUNCTION
Gray/brown	GND
Black	Input 1
Violet	Input 2
Gray/pink	Input 3
Red/blue	Input 4
White/green	Input 5
Brown/green	Input 6
White/blue	Analog input
White/yellow	Output 1
Yellow/brown	Output 2
White/gray	Output3
Red	GND

Pin assignment: ZK-PD2N-3

JST ZPD-10 Housing: ZPDR-10V-S Contact:SZPD-002T-PO.3		
PIN NO.	COLOR	FUNCTION
1	Blue	shielding
2	Green	GND
3	Yellow	+ UB LOGIC
4		NC
5	Pink	CAN-
6	Gray	CAN+
7	Black	GND
8	Brown	+VB
9	Brown	+VB
10	Black	GND

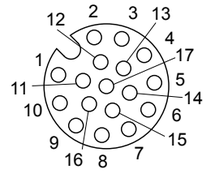
JST ZPD12 Housing: ZPDR-12V-S Contact:SZPD-002T-PO.3		
PIN NO.	COLOR	FUNCTION
1	Gray/brown	GND
2	Black	Input 1
3	Violet	Input 2
4	Gray/pink	Input 3
5	Red/blue	Input 4
6	White/green	Input 5
7	Brown/green	Input 6
8	White/blue	Analog input
9	White/yellow	Output 1
10	Yellow/brown	Output 2
11	White/gray	Output 3
12	Red	GND

D-SUB FEMALE CONNECTOR		
PIN NO.	COLOR	FUNCTION
1		NC
2	Pink	CAN-
3	Green	GND
4		NC
5	Blue	shielding
6	Green	GND
7	Gray	CAN+
8		NC
9	Yellow	+ UB LOGIC
housing	shielding	

EXTERNAL I/O	
COLOR	FUNCTION
Gray/brown	GND
Black	Input 1
Violet	Input 2
Gray/pink	Input 3
Red/blue	Input 4
White/green	Input 5
Brown/green	Input 6
White/blue	Analog input
White/yellow	Output 1
Yellow/brown	Output 2
White/gray	Output3
Red	GND

Connection cable

Pin configuration

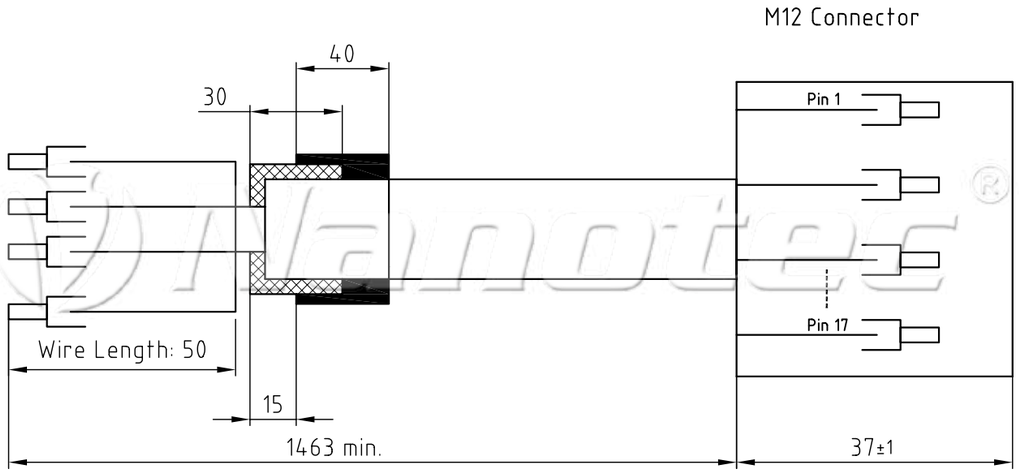


ZK-TW-18-2M	
PIN	**COLOR**
1	Brown
2	Blue
3	White
4	Green
5	Pink
6	Yellow
7	Black
8	Gray
9	Red
10	Violet
11	Gray/pink
12	Red/blue
13	White/green
14	Brown/green
15	white/brown
16	Yellow/brown
17	White/gray

Order identifier

M12 signal cable for PD2-N4118 with IP protection	
ZK-M12-17-1M-2-S-FIN	17-pin, 1.5 m, angled connector, shielded

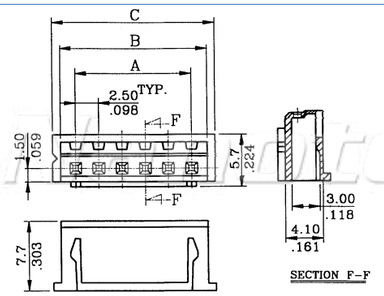
ZK-M12-17-1M-2-S-FIN



Notes

Plug connector

Socket housing JST-XHP



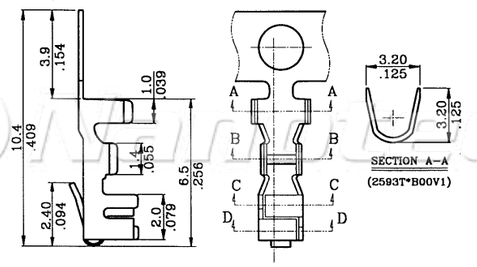
Pin assignment

Pins	Ⓧ	Size A	Size B	Size C
2	2	2.5	5.7	7.3
3	3	5.0	8.2	9.8
4	4	7.5	10.7	12.3
5	5	10.0	13.2	14.8
6	6	12.5	15.7	17.3
8	8	17.5	20.7	22.3

Order identifier

ZCJST-XHP -Ⓧ

Contact springs AWG22 - 26



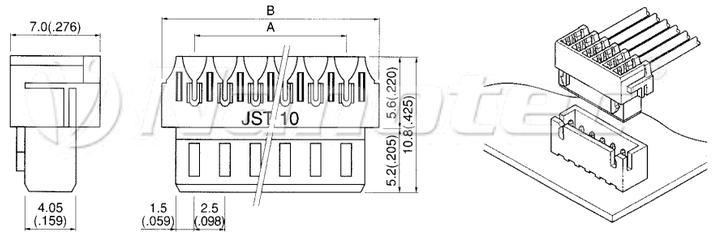
Order identifier

ZCJST-SXH

Order identifier

Crimping tool for individual contact springs
ZC2WC-110

Insulation displacement connection technology, connector for AWG24



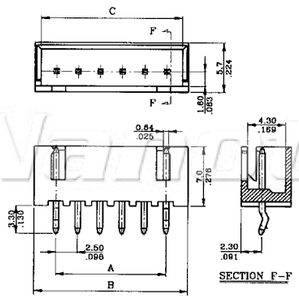
Pin assignment

Pins	Ⓧ	Size A	Size B
4	04NR	7.5	12.5
5	05NR	10.0	15.0
6	06NR	12.5	17.5
8	08NR	17.5	22.5

Order identifier

ZCJST-Ⓧ

Pin connector for RM print assembly 2.54 mm (JST-XHP)



Pin assignment

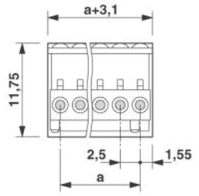
Pins	Ⓧ	Size A	Size B	Size C
4	SL4-2.54	7.5	12.5	11.1
6	SL6-2.54	12.5	17.5	16.1
8	SL8-2.54	17.5	22.5	21.1

Order identifier

ZC2-Ⓧ

Plug connector

COMBICON connector socket housing



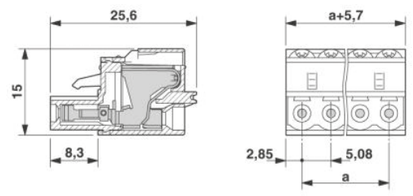
Order identifier

ZCPHOFK-MC0.5 -Ⓧ

Pin assignment

Pins	X	Size A
2	2	2.5
4	4	7.5
5	5	10.0
8	8	17.5
12	12	27.5

COMBICON HC connector socket housing



Order identifier

ZCPHOFKC-2.5HC -Ⓧ

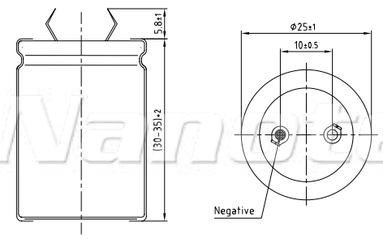
Pin assignment

Pins	X	Size A
2	2	5.08
4	4	15.24

Charging condenser

Parallel to the operating voltage, charging capacitors are required on drivers or Plug&Drive stepper motors so that the admissible voltage is not exceeded during the braking process.

Outline drawing (in mm)



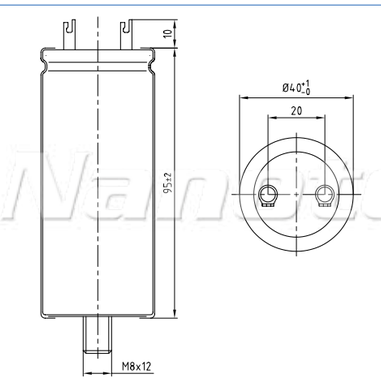
Charging capacitor 4,700 µF

Capacitance: 4.700 µF / 50 V
Temperature range: -40 to +85 °C
Dimensions: cylindrical aluminum cup, approximately 25X35 mm
Capacitance tolerance: ± 20%
Grid dimensions: 10 mm

Order identifier

Z-K4700/50

Outline drawing (in mm)



Charging capacitor 10,000 µF

Capacitance: 10,000 µF / 100 V
Temperature range: -40 to +105 °C
Dimensions: cylindrical aluminum cup, approximately 40 x 95 mm
Capacitance tolerance: -10% ~ 30%
Grid dimensions: 20 mm

Order identifier

Z-K10000/100

Damper

The shock absorbers D28, D40 and D56m from Nanotec can be installed on all stepper motors with a second shaft end (28-58 mm size). Alongside the improved settling time, system resonances are suppressed, and vibrations and motor noises in the lower speed range are greatly reduced to a minimum.
With device-specific resonance and noise problems, device setup is made considerably easier by fitting the damper.

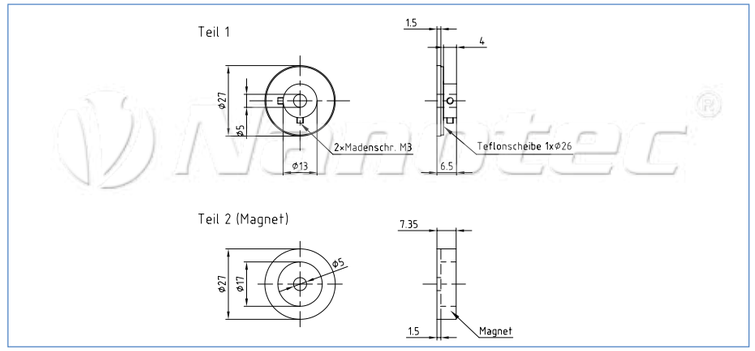
ZD-D28

for all stepper motors with shaft diameter of 5.0 mm and B shaft, weight: 26 g. Adapted for stepper motor sizes ST28..

Order identifier

ZD-D28

Outline drawing (in mm)



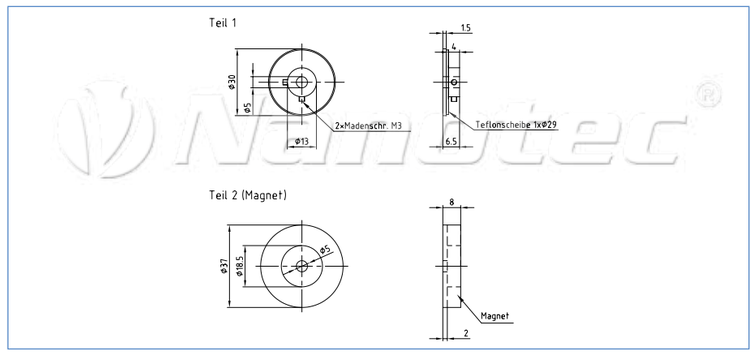
ZD-D40

for all stepper motors with shaft diameter of 5.0 mm and B shaft, weight: 40 g. Adapted for stepper motor sizes ST41.., ST42..

Order identifier

ZD-D40

Outline drawing (in mm)



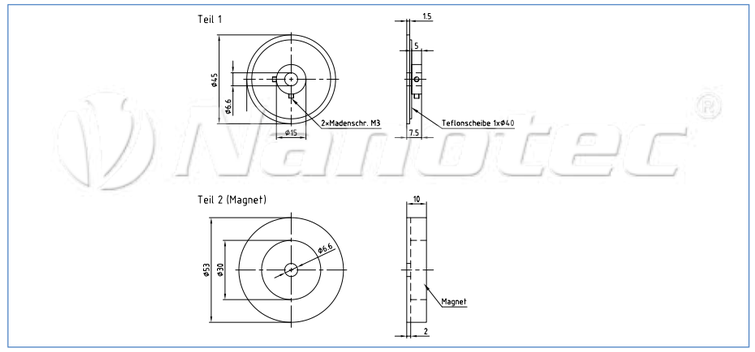
ZD-D56

for all stepper motors with shaft diameter of 6.35 mm and B shaft, weight: 100 g. Adapted for stepper motor sizes ST57.., ST59..

Order identifier

ZD-D56

Outline drawing (in mm)



Damper for mounting flange

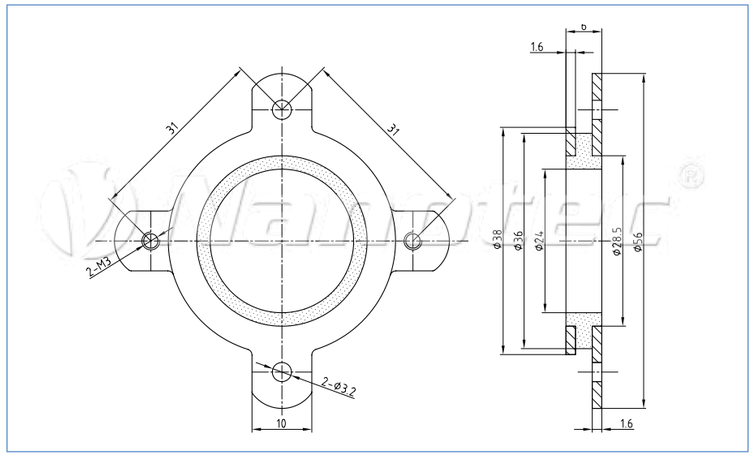
The vulcanized rubber secured between 2 flange rings serves in the ZD shock absorbers first and foremost to suppresses the rigid-body sound*, which, depending on frequency, can be reduced in relation to direct flange installation and its size, design and stability to approx. 3 to 10 dB(A). due to the different sound speeds - steel / air / rubber = 5000 / 331 / 50 m/s - and the dampening tendency of the ZD-DF shock absorber to vibrate, a cost-effective dampening of noise is possible.

Compared to the well-known rubber silencer, the ZD silencer still provides an acceptable setting of the often important axis spacing between motor shaft and shaft to be driven.

The interrupted flange cooling surface (additional cooling surface that is often utilized for direct flange mounting) must be taken into account for the admissible motor temperature.

*** Noises created during their generation** are initially rigid-body noise, and are first emitted as airborne noise. If these waves of noise impact a component, e.g. a housing wall, it will be put into vibration. Through the vibration, this wall (small bending vibrations), the air in the room is in turn stimulated and is audible to humans as airborne noise. Because every component has its own resonance frequency, countless other sources of noise can be stimulated and thus also amplified.

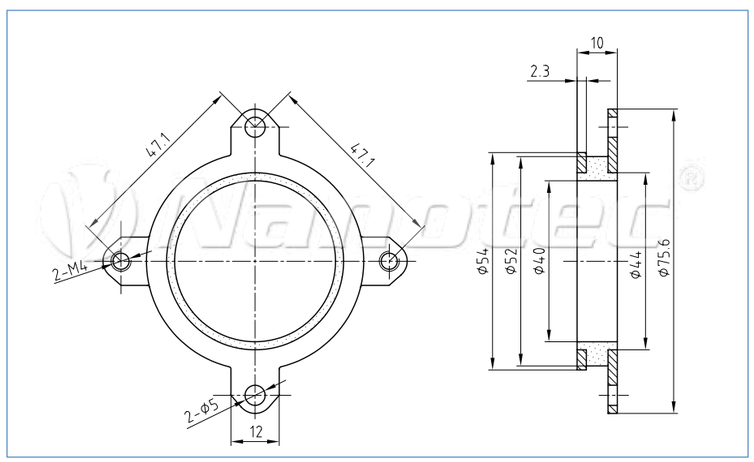
ZD-DF40



Order identifier

ZD-DF40

ZD-DF56



Order identifier

ZD-DF56

Threaded spindles

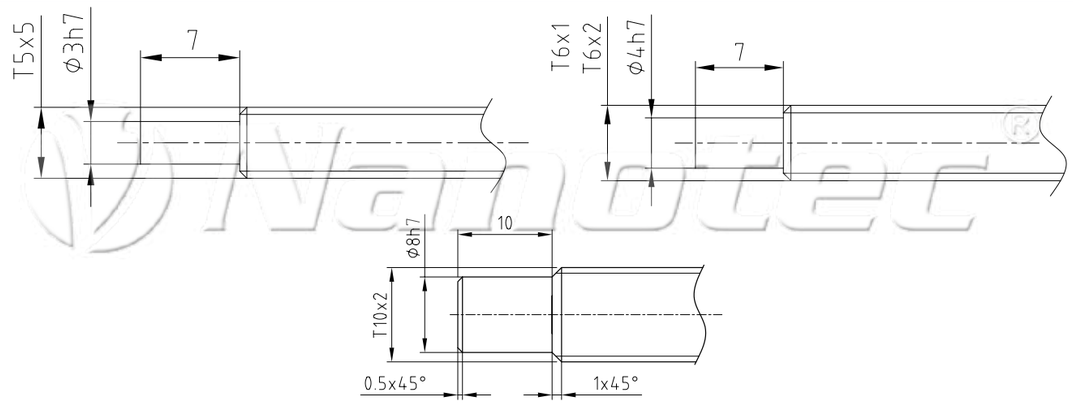
Fast and economic for the complete module
To realize easy and fast linear movements with a stepper motor, we offer the matching threaded spindles for every linear actuator or linear motor. Not only does this reduce the order and delivery cost, it also increases compliance with the specified tolerances at the same time.
Lubrication:
The lubrication intervals depend on the external operating conditions. Bronze nuts always have to be lubricated regularly (For example, with Klüber Microlube GBUY131).

Order identifier

ZS T 6 1 200 1

- T = trapezoidal
- Thread size
- Pitch of screw
- Spindle length 200 = 200 mm (standard) (others on request)
- With standard finishing

Standard finishing



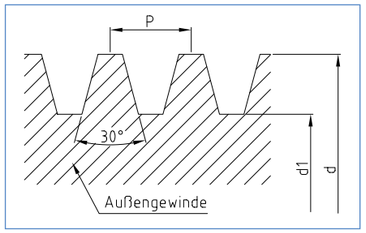
Lead screws p = 1 - 5 mm

The pitch of p = 1, 2 and 5 mm offers an extended range of applications, where larger strokes are conveyed in a minimum of time.

Spindle material
Material No.: 1.4021 = Stainless (not resistant to acid and salt water) all lead screw other than T6X2 (1.4404)

Tensile strength
760 N/mm²

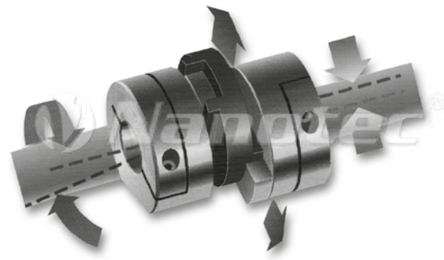
Spindle with lead screw



Available spindles

Thread size Ø	Pitch p	Thread pitch delay mm/on section	Exterior - Ø d mm	Core - Ø d1 mm	Standard axial play	for linear actuator	available spindle lengths mm
T3.5x1	1.00	± 0.1 / 300 mm	3.50	2.30	0.03	L.....-T3.5x1	200, 300
T6x1	1.00	± 0.1 / 300 mm	6.00	4.70	0.03	L.....-T6x1	200, 300
T6x2 P1	2.00	± 0.1 / 300 mm	6.00	4.70	0.03	L.....-T6x2	200, 300
T5x5	5.00	± 0.1 / 300 mm	5.40	3.60	0.10	L.....-T5x5	200, 300
T10x2	2.00	± 0.1 / 300 mm	9.70	8.20	0.06	L.....-T10x2	200, 300

Shaft couplings



The Oldham couplings from Nanotec are easy to install due to the efficient design, and can transfer high forces at low shaft displacement. Through the clamp fastening, damage to the shaft is ruled out.
A nylon transmission disc dampens noise and provides good insulation properties (3 kV between two shafts) with a potential-free construction.

Use
Where a zero-play transfer of force is needed: Stepper motors, servo motors, encoders, tachogenerators, etc.

Temperature range: -20 to +60 °C
Materials: Hub aluminum alloy 2011T3 and 2011T8 BS4300/5FC1
Transfer plate: Nylon 11 (colorless)
Tapped blind hole: Length of the parallel hole ±0.2. Drill holes end with 118° bevel

Operating factors

Maximum torques based on drives with no displacement or axial movement.
The operating ratios are multiplied by the load moments as explained, e.g.

Load moment of the application = 1 Nm
Operating factor = 2
Required torque = 2 Nm

Load duration	Operating factor
Momentary load	1
1 hours per day	2
3 hours per day	4
6 hours per day	6
12 hours per day	8

Order identifier

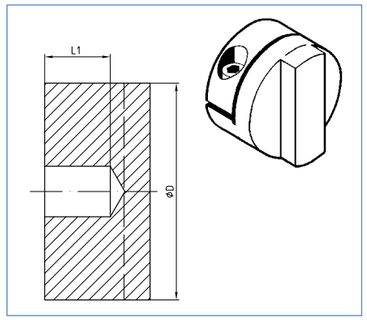
ZW-X (e.g. ZW-235-19-20)

Order 2 hubs + 1 transmission disc

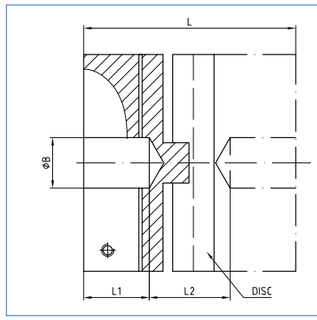
From 50 pcs, special boreholes are possible!

Order number with special hub drill hole:
e.g. 8.0 mm= ZW - 235-19-99-8.0

Hubs with blind hole



Outline drawing (in mm)



Coupling-specific parameters

Size	Short-circuit torque Nm	Max. displacement @3000 r.p.m. Angle ±°	Radial ±mm	Axial ±mm	Static break torque Nm
19	1.7	0.5	0.2	0.10	10
25	4.0	0.5	0.2	0.10	13
41	17.0	0.5	0.2	0.15	57

Available shaft couplings

Hubs	Size	Hub hole +0.03/-0 mm	Dimensions Ø D	L	L1	L2	Fixing screws Setting screw	removal torque Nm	Inertia torque kgm^2x10^{-8}	Weight	Transmission disc Order number
235-19-20	19	5	19.1	22.0	6.3	9.4	M3	0.94	67	12	**235-19-0**
235-19-99	19	X	19.1	22.0	6.3	9.4	M3	0.94	67	12	**235-19-0**
234-25-24	25	6.35	25.4	28.4	8.6	11.2	M4	2.27	252	31	**234-25-0**
234-25-28	25	8	25.4	28.4	8.6	11.2	M4	2.27	252	31	**234-25-0**
234-25-99	25	X	25.4	28.4	8.6	11.2	M4	2.27	252	31	**234-25-0**
234-41-31	41	9.525	41.3	50.8	16.7	17.4	M5	4.62	3327	148	**234-41-0**
234-41-38	41	14	41.3	50.8	16.7	17.4	M5	4.62	3327	148	**234-41-0**
234-41-99	41	X	41.3	50.8	16.7	17.4	M5	4.62	3327	148	**234-41-0**

Terms and Conditions of Sale and Delivery

§ 1 Ranges of Application

1.1 Our terms and conditions of sale and delivery shall apply exclusively. Any terms of the buyer that are in conflict with or differ from our sales or delivery terms are not recognized by us, unless we have agreed to their validity in writing. Our terms and conditions of sale and delivery shall also apply if we carry out the delivery to the buyer without any reservation and if we are aware of any conditions of the buyer that conflict or differ from our terms and conditions of sale and delivery.

1.2 All agreements made between us and the buyer for the purpose of the execution of this contract must be made in writing in this contract.

1.3 Our terms and conditions of sale also apply for all future transactions with the buyer.

§ 2 Quotation and Order

2.1 Our quotations are subject to change. Binding contracts of delivery will only be concluded through our order confirmation unless a written contract has been concluded. If the order is to be qualified as a quotation according to § 145 of the German Civil Code [BGB], we can accept it within four weeks. No additional agreements and promises will be effective unless included in the order confirmation and/or confirmed in writing. Should the sales tax not be separately identified in the quotations, the price quoted shall be plus legally applicable sales tax.

2.2 Orders which are to be carried out on the same working day on which they arrive at Nanotec must arrive at Nanotec by 11 am at the latest. Nanotec retains the right to accordingly extend the delivery period in the case of large orders for individual products.

2.3 Written orders which repeat a previous telephone order without expressly pointing out the repetition shall be regarded as an additional order.

2.4 In case of writing, printing and calculation errors in the catalog, quotation, on the Internet or inadequate creditworthiness of the buyer, Nanotec retains the right to withdraw from the contract. In such cases, the buyer has no claim for damages.

2.5 All photographs, drawings, weight, measurement, performance or other constructional data in the catalog, quotation and on the Internet are only binding insofar as it has been expressly agreed upon. Nanotec retains the right of changes and deviations. The customer is solely responsible for its intended use for the ordered items.

2.6 Nanotec retains the right to agree the delivery period of large quantities separately.

§ 3 Prices and Terms and Conditions of Payment

3.1 All prices are quoted in euros. Unless otherwise agreed, the prices are ex works plus dispatch and packing costs and plus sales tax in the currently valid legal amount.

3.2 Nanotec retains the right to increase prices in catalogs and quotations and on the Internet accordingly if, after publication of prices in the catalog, quotation or on the Internet, price increases occur, in particular due to collective wage agreements, an increase in material prices or currency fluctuations. These increases will be verified to the buyer on request.

3.3 Unless otherwise agreed, the net purchase price (without any deductions) is to be paid within thirty days of the invoice date or within ten days with 2% cash discount. If the buyer is in default of payment, Nanotec will be entitled to claim interest on the amount in arrears at the rate of 4% above the respective base rate of the Deutsche Bundesbank per year. If Nanotec verifiably incurs higher damages due to the delay, Nanotec will be entitled to demand reimbursement for such costs.

3.4 The retention of payments or the setting off of any counterclaims of the buyer disputed by Nanotec are not admissible.

3.5 If a substantial deterioration of the financial circumstances of the buyer occurs or if Nanotec is informed of a previous deterioration of the financial circumstances after the conclusion of the contract, Nanotec will be entitled to demand either payment in advance or a security payment at its discretion. In the case of new customers, Nanotec retains the right of delivery against cash on delivery or payment in advance.

§ 4 Delivery

4.1 Unless otherwise agreed, terms of delivery shall be ex warehouse Feldkirchen/Munich. The risk will be transferred to the buyer as soon as the consignment leaves the works of Nanotec, also in the case of partial deliveries.

4.2 Information on the period of delivery is non-binding unless the date of delivery has been bindingly agreed. § 2.1 of these terms and conditions of sale and delivery remains unaffected.

4.3 If the buyer grants Nanotec an adequate extension with threat of refusal after Nanotec has already defaulted, the buyer shall be entitled to withdraw from the contract after the futile expiry of this extension. The buyer shall only be entitled to claims for damages due to non-fulfillment up to the amount of the foreseeable damage if the delay is intentional or due to gross negligence. Moreover, the liability for damage shall be restricted to 50 % of the damage incurred.

4.4 If Nanotec is in delay with delivery for reasons for which Nanotec is responsible, the buyer will be entitled to demand a generalized compensation for delay to the amount of 0.5 % of the net good value for each complete week of delay, to a maximum of 5 % of the net value of the goods.

§ 5 Outline Supply Contracts

5.1 If a master supply agreement is concluded, the buyer's period of acceptance shall be 12 months from the day of confirmation of the order unless any written agreement deviating from this has been made. Accordingly, the master supply agreement is broken down into the resulting partial quantities over a period of 12 months from acceptance of the first partial delivery. After the expiry of the period of acceptance, Nanotec shall be entitled to invoice the remaining goods at its discretion or to claim damages for the delay of acceptance. The amount of the damages generally amounts to a lump sum of 25% of the order value unless the buyer can prove a lower damage amount or Nanotec a higher damage amount.

5.2 Unless otherwise agreed, Nanotec will be entitled to pass on increases in material and wage costs to the buyer if the master supply agreement exceeds a handling period of 12 months. 5.3 If the buyer states a binding date of acceptance to Nanotec, it must adhere to this date. If the buyer defers the stated binding date more than once, Nanotec must be compensated for the resulting additional expenses at a flat rate of 50 euros per deferral.

§ 6 Retention of Title

6.1 The goods delivered remain the property of Nanotec until the buyer has paid all outstanding amounts which Nanotec has now or in future.

6.2 The buyer is entitled to resell the purchased goods in the normal course of business; the buyer now, however, assigns all claims to Nanotec in the amount of the final invoice total (including sales tax) that accrue to it from the resale against his buyers or third parties, and this is irrespective of whether the purchased goods have been resold without or after processing. The buyer shall remain entitled to collect the outstanding amount even after the assignment. Nanotec's right to collect the receivable itself remains unaffected by this. However, Nanotec undertakes not to call in the account receivable so long as the buyer fulfills its obligations to pay arising from the proceeds received, is not in default, in particular, so long as no application for instigating insolvency proceedings has been submitted or settlement proceedings or inability to pay exists. Should this be the case, however, Nanotec may demand from the buyer to be informed about the assigned receivables and the parties who owe them, to provide all information required for collection, to submit the necessary documentation and to inform the debtors (third parties) of the assignment.

6.3 Processing or alteration of the purchased goods by the buyer is always undertaken on behalf of Nanotec. If the purchased goods are processed with other objects which are not the property of Nanotec, Nanotec shall acquire co-ownership of the new items in proportion to the value of the purchased goods to the other processed goods at the time of processing.

6.4 In the case of assertion of the retention of title, the buyer already declares the toleration of the entry of the business premises now for the retrieval of the retained goods.

§ 7 Guarantee

7.1 The warranty rights of the buyer presuppose that he has satisfied his duty to inspect and complain according to §§ 377 of the German Commercial Code [HGB] in accordance with regulations.

7.2 In the case of sampled stepper, servo, linear and gear motors tested by the buyer before acceptance, any warranty is excluded unless they have not been sufficiently tested in relation to performance, quiet running, service life and operational conditions.

7.3 Should the purchased goods have a defect for which Nanotec is responsible, Nanotec shall be entitled to remedy the defect or supply a replacement at its own discretion. If Nanotec is not prepared to rectify the defect/supply a replacement or is not in a position to do so or if this is delayed for reasons for which Nanotec is responsible or if the rectification of the defect or the supply of replacement fails in any other way, the buyer shall be entitled at its discretion to withdraw from the contract or to demand a corresponding decrease of the purchase price.

7.4 Unless agreed otherwise, no further claims of the buyer – for whatever legal reasons – are admissible. Nanotec therefore does not accept liability for damages that do not occur to the article of sale itself; in particular, Nanotec accepts no liability for loss of profits or for other financial losses of the buyer.

7.5 The above liability disclaimer shall not apply if the cause of the damage was based on intent or gross negligence. It is also not applicable if the buyer claims damages due to non-fulfillment of a guaranteed property according to §§ 463, 480 Para 2 of the German Civil Code [BGB].

7.6 If Nanotec negligently violates an essential contractual duty, Nanotec's obligation for compensation for damage to property or physical injury shall be restricted to the liability insured by Nanotec's product liability insurance. Nanotec is prepared to present the policy to the buyer on request.

7.7 The warranty period is twelve months counted from the transfer of risk.

7.8 Nanotec is not the manufacturer of all products included in the scope of supply. The customer himself is responsible for the application of the products.

§ 8 Wrong Orders

8.1 The buyer shall only be entitled to return goods to Nanotec if it sends them back to Nanotec in the original condition and the original packaging and Nanotec has consented to the return shipment in advance in writing. In the case of a fault of the buyer (wrong order, double shipment, packaging unit not observed, etc.), Nanotec shall be entitled to invoice the buyer for the contractual costs.

§ 9 Overall Liability

9.1 Any further liability for damage as provided by §§ 7.5 to 7.7 is excluded – irrespective of the legal nature of the claim made.

9.2 The stipulations according to Paragraph 1 do not apply to claims according to §§ 1, 4 of the German Product Liability Act. The same applies for initial inability or justified impossibility.

9.3 Insofar as Nanotec's liability is excluded or restricted, this will also apply to the personal liability of Nanotec's employees, staff, representatives and vicarious agents.

§ 10 Export Control

10.1 In recognition of the American and other applicable (in particular, German) export control regulations, the buyer undertakes to obtain all required export licenses or other documents at his own cost before the export of the products or technical information, which he received from Nanotec.

10.2 The buyer undertakes not to sell, export, re-export, supply or pass on in any other way such products or technical information either directly or indirectly to persons, companies or countries if this violates any laws or regulations of the United States of America or other countries (in particular Germany). The buyer undertakes to notify all consignees of these products or technical information of the necessity to adhere to these laws and regulations. The buyer is responsible for acquiring all licenses and export and import documents which are required for the application of the products at the buyer's own cost. The rejection of an export license does not entitle the buyer to withdraw from the contract or indemnity claims.

§ 11 Invalid Clauses

11.1 Should any individual clause(s) be or become invalid, this shall not affect the validity of the other clauses in case of doubt. The General Terms and Conditions of Nanotec will remain unaffected in all other aspects and the invalid clause will be replaced by an admissible clause which best fits the purposes of the contract.

§ 12 Place of Fulfillment, Legal Venue

12.1 If the buyer is a merchant who has been entered as such in the commercial register, the jurisdiction shall be Nanotec's registered office; Nanotec is also entitled to sue at the buyer's location.

12.2 Unless otherwise agreed in the order confirmation, the registered office of Nanotec is Feldkirchen/Munich.

12.3 The application of the general UN purchase right (CISG) is excluded.

12.4 Any assignment of claims which the buyer incurs from its business connection with Nanotec® is excluded.

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Nanotec®

Notes

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